COLLINS

51R-1

VHF NAVIGATION RECEIVER

TEMPORARY COPY

INSTRUCTION BOOK

INSTRUCTION BOOK

for

51R-1 VHF NAVIGATION RECEIVER

P.A. Kosky

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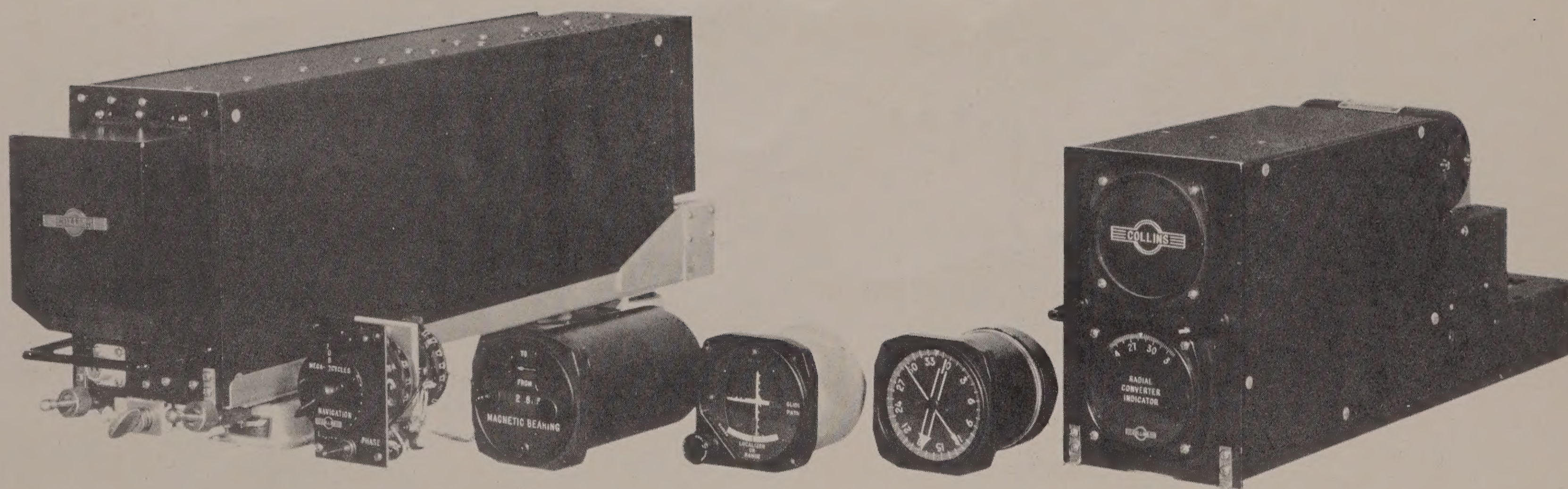
Manufactured By

COLLINS RADIO COMPANY, Cedar Rapids, Iowa



A B C D E F

COLLINS VHF NAVIGATION EQUIPMENT

A. 51R Receiver on Shockmount

B. 314U-1 Control Box

C. 336A-1 Radial Selector

D. Deviation Indicator — Weston 888 Type 3
Collins 458 0126 00

E. 332C-1 Radio Magnetic Indicator

F. 351A-1 Accessory Unit (provides mounting for
2 337A-1 Radial Converter Indicators
and 3 333B Servo Amp. for R.M.I.
and 2 416N-1 Power Units for 2 51R's)

Photo shows 1 337A-1 and 416N-1 unit mounted on 351A-1 Accessory Unit.

he would set up a track leading away from him at an angle of 315 degrees, and passing directly over Newark. The needle at the top of the track selector would then move up and point to the word TO indicating that the instrument should be read "Track 315 to the station."

Having made the track selector setting, the pilot then flies his right-left needle on the deviation indicator, this needle always pointing toward the track. If the airplane is off course to the right, the needle points to the left, indicating that the desired track line is located to the left of the airplane, and telling the pilot that his aircraft should be maneuvered to the left to get onto the desired course line.

Continuing flight on the desired track, the aircraft passes over the station. In low-frequency range practice, passage over the station is indicated by the familiar cone of silence, the flashing of the marker light from the Z marker and the 3000 cycle tone in the pilot's headset likewise furnished by the Z marker. The marker function in the VOR system is provided by the TO-FROM indicator, which has in the past been improperly named the ambiguity indicator. This instrument should be considered strictly as a marker. On passage over the station, the needle moves from TO to FROM, and the track selector is then read by the pilot"315 degrees from Newark," which is an accurate description of the pilot's angular position with respect to the Newark station. Continuing northwest from Newark on track 315, the pilot may wish to execute a procedure turn and turn to Newark along the same track. At an appropriate distance out on the 315 track, the pilot executes his procedreturn, and somewhere during the last half of this turn switches knob B on the track selector. This knob moves a shutter in front of the counter numerals obscuring the figures 315 and revealing the figures 135. At the same time an internal switch in the instrument, operated by the same knob, reverses the TO-FROM indicator which now switches over and points to TO. The pilot then reads his omnibearing selector as magnetic bearing "135" to the station. Pilots familiar with localizer flying will remember that when an airplane flies areverse heading on a localizer, the cross pointer sensing is reversed. This is not the case in omnidirectional range flying. When the pilot completes his procedure turn, and reverses his selector through the operation of knob B, as described, not only does the selector tell him the track to the station, but it likewise reverses the deviation indicator readings so that follow-the-needle type of sensing is still correct.

Sensing is always normal when flying along a line somewhere near the selected track, on a heading which approximately agrees with the track selector reading.

The radio magnetic indicator is shown in figure 4. This instrument is universal in character, and may be used with either the VOR receiving equipment or as an indicator for one or two ADF's. Considering it as an ADF indicator first, it behaves just as the present-day compass repeater on the instrument panel with the addition of a stabilized magnetic scale. The stabilized

scale behaves as though there were a third crew member who busied himself in continuously resetting the scale of the indicator to agree with the magnetic compass. This continuous resetting or synchronizing service is performed in the RMI by a servo motor coupled to the magnetic compass through a suitable amplifier, included as part of the VOR receiving equipment. In the photograph shown, the double bar needle is pointing to a station to the left and ahead of the aircraft. The magnetic bearing of that station from the aircraft is 226 degrees. The bearing of the aircraft from the station (read on the other end of the same needle) is 26 degrees; in other words, the airplane is northeast of that station. The aircraft's heading is 256 degrees magnetic. The single barred needle is pointing toward a station which is to the right and ahead of the aircraft, the bearing of the station from the aircraft being 312 degrees. It can be seen that the full story with respect to magnetic and radio bearings is portrayed in simple form on a single instrument.

The system layout of the VOR receiving equipment provides for coupling either one of the RMI needles to the omni-range receiver so that direct ADF type bearings can be taken on omni stations. It is probable that the individual airline will work out switching arrangements which will make it possible for the pilot to put, say, the double barred needle on the VOR equipment and the single barred needle on the standard ADF, or to make other use of the needles as desired.

Figure 5 shows typical instrument readings which would be observed in an airplane flying toward radial 305 in a Northerly direction, and then turning left to fly over the station along this same radial.

Starting at A, it will be seen that the needle of the RMI points to the omni station at the left, the bearing to the station being approximately 320 degrees. The magnetic scale of the RMI reads zero, since the airplane is flying directly North. The pilot, knowing that he wishes to approach the station along radial 305 has set his omni-bearing selector to read 305, TO. The vertical needle of the deviation indicator (cross pointer indicator) reads to the right.

The airplane proceeds north to point B. It will be seen now that the needle of the RMI has swung still further to the left, and now reads 308 degrees. The azimuth card of the RMI is still reading zero as the airplane is still headed straight North. The vertical needle of the deviation indicator has swung in close to the center, showing the airplane is close to the desired track. At this point the pilot starts to turn to the left, and arrives at point C, whereupon the needle of the RMI reads 305, but is now pointing dead ahead indicating that the station is directly ahead of the pilot. The magnetic scale of the RMI reads 305 also. The vertical needle of the deviation indicator is now centered showing that the airplane is accurately established on course.

INTRODUCTION

Figure 6 shows a plane as having passed over the station on track 305, the pilot's intention being to proceed along that track to an intersection with a landing system localizer at his terminal field. At point D, the pilot's instruments show that he has just passed the station, but that he has slipped a little bit to the right of his desired track. The RMI needle has reversed, and points back toward the station which now bears 160 degrees from the plane, while the outer scale of the RMI shows 307 degrees, indicating that the pilots's heading is slightly in error to the right. The vertical needle of the deviation indicator points to the left showing that the desired flight track is to the left of the airplane. The ambiguity indicator or TO-FROM needle has been moved down to indicate FROM. The track selector reading is now "305 degrees from the station." The airplane proceeds, readjusting itself to the correct track line, until it arrives at point E. whereupon the pilot operates his frequency selector to pick up the localizer and glidepath of the ILS at the terminal. This frequency might be 109.9, for example. The instruments now read as follows: The needle of the RMI is now dead, since the receiver has been switched away from the VOR station. The scale of the RMI is still in operation and shows the heading of the aircraft to be 305 degrees. The deviation indicator reads to the left showing that the desired runway line lies to the left of the airplane's present position. In the simple case chosen, the inbound runway heading is zero degrees magnetic. The track selector is now inoperative, and the TO-FROM needle has swung to a neutral or centered position informing the pilot that he is to disregard the readings or settings of this instrument.

The pilot proceeds to point F, where his instrument readings are approximately the same as shown at E, except that the deviation indicator needle will have moved in toward center, showing that he is approaching the desired course line. From this point on, he proceeds with his landing, using normal ILS technique without further reference to the VOR system.

Figure 7 shows the operation and use of the instruments during a procedure turn shortly after passage over a VOR station. In this example, the plane is shown at A, proceeding northeast along track 45. The start of the procedure turn is at point B. Instrument readings at points A and B are the same. The needle of the RMI points directly aft toward the station. The RMI dial reading under the needle is 225 degrees. The deviation indicator reads on-course. The needle on the track selector reads FROM, and the complete reading of this instrument is magnetic bearing 45 degrees from the station.

At point B, the pilot turns 45 degrees right, and begins his standard procedure turn. The point C, the needle of the RMI still points back toward the station which is now to the right rear of the plane. The heading of the airplane is now 45 degrees to the right of 45, or 90 degrees. The bearing of the station from the plane is now 240 degrees, and this bearing is read off under the needle end of the RMI pointer. The deviation indicator reads strongly to the left, showing that the pilot has moved well to the right of his original VOR track.

The pilot now starts his standard rate turn to the left, and at point D approximately half way around the turn, switches the shutter of his track selector so as to set up his deviation indicator for normal sensing, on his inbound flight. The RMI needle now points to the station which is over the airplane's left wing at a bearing of approximately 230 degrees. The airplane is still in its standard turn, and its heading at this moment is 315 degrees. The deviation indicator has now swung far to the right indicating that when the pilot approaches the end of his standard turn, the desired course line will lie to the right. The track selector shutter switch has been thrown to the left to reverse the track selector reading which now reads magnetic bearing 225 to the station.

At point E, the plane is headed almost directly toward the station, and is nearly on the desired approach track. The RMI needle shows that the station is slightly to the left of the nose of the plane at a bearing of 227 degrees. The heading of the plane at this moment is 232 degrees, and the pilot still has 7 more degrees of his turn to complete. From this point on in to the station, the pilot flies track 225 in a normal manner.

From all of the explanation and illustrations give, it will be shown that the VOR is simply a visual range which can be swung around to suit the pilot to give him a visual track in any direction leading toward or away from the station. At the same time the system is tied in with the magnetic compass to produce readings on the radio magnetic indicator identical to those which he has been accustomed to using in ADF procedure. The previous knowledge which the pilot has gained in flying ILS localizers and in ADF procedure work should enable him to adapt himself to the VOR system with little difficulty.

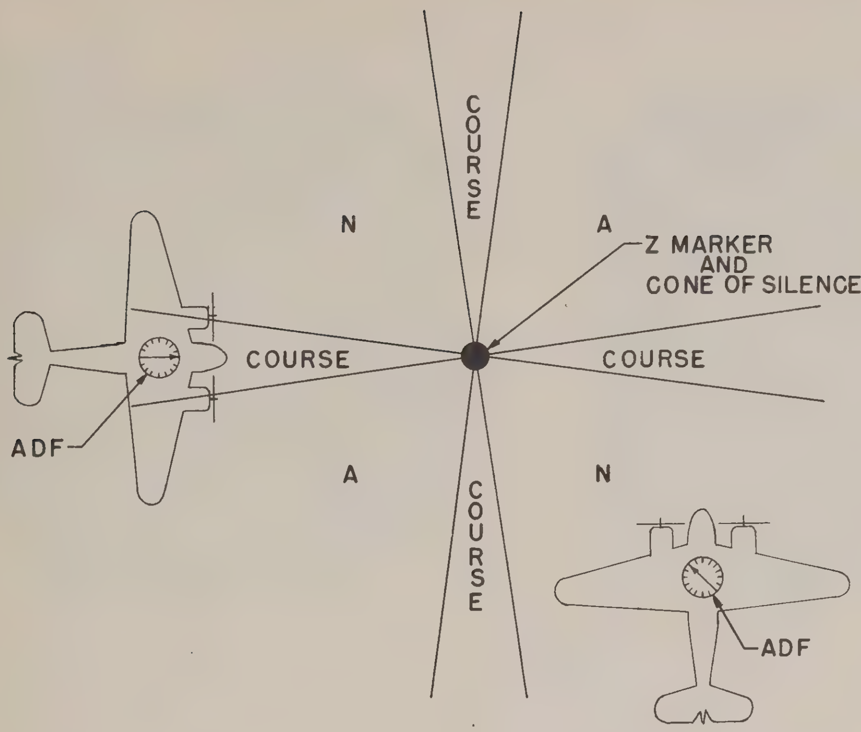


Figure 1 Four-Course Range

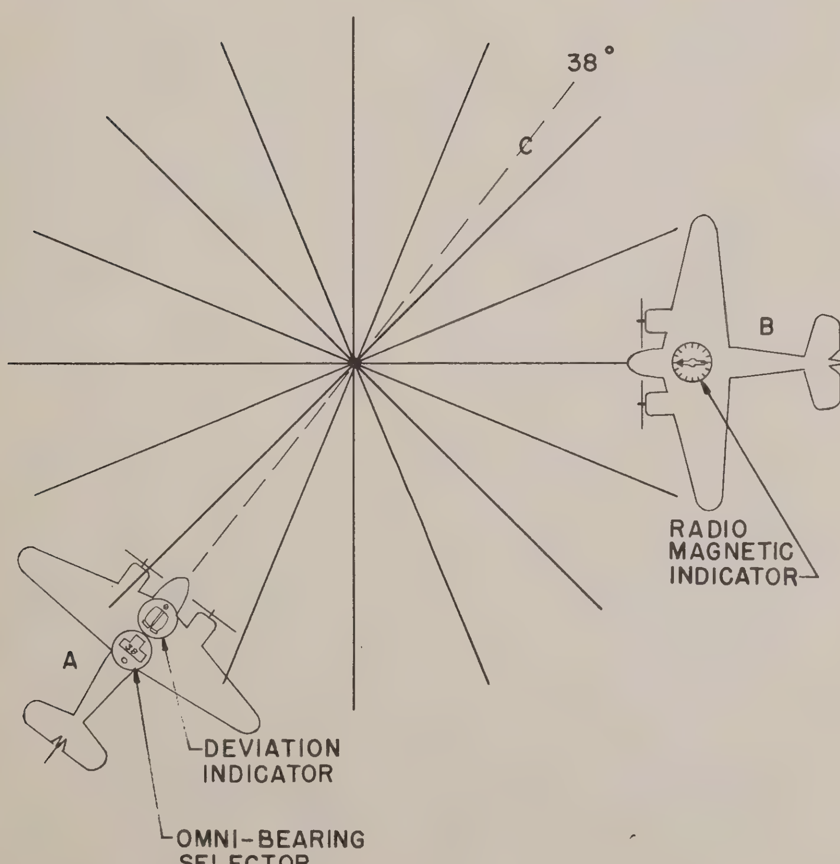


Figure 2 Visual Omni-Range

FIGURE 3 OMNI-BEARING SELECTOR

FIGURE 4 RADIO MAGNETIC INDICATOR

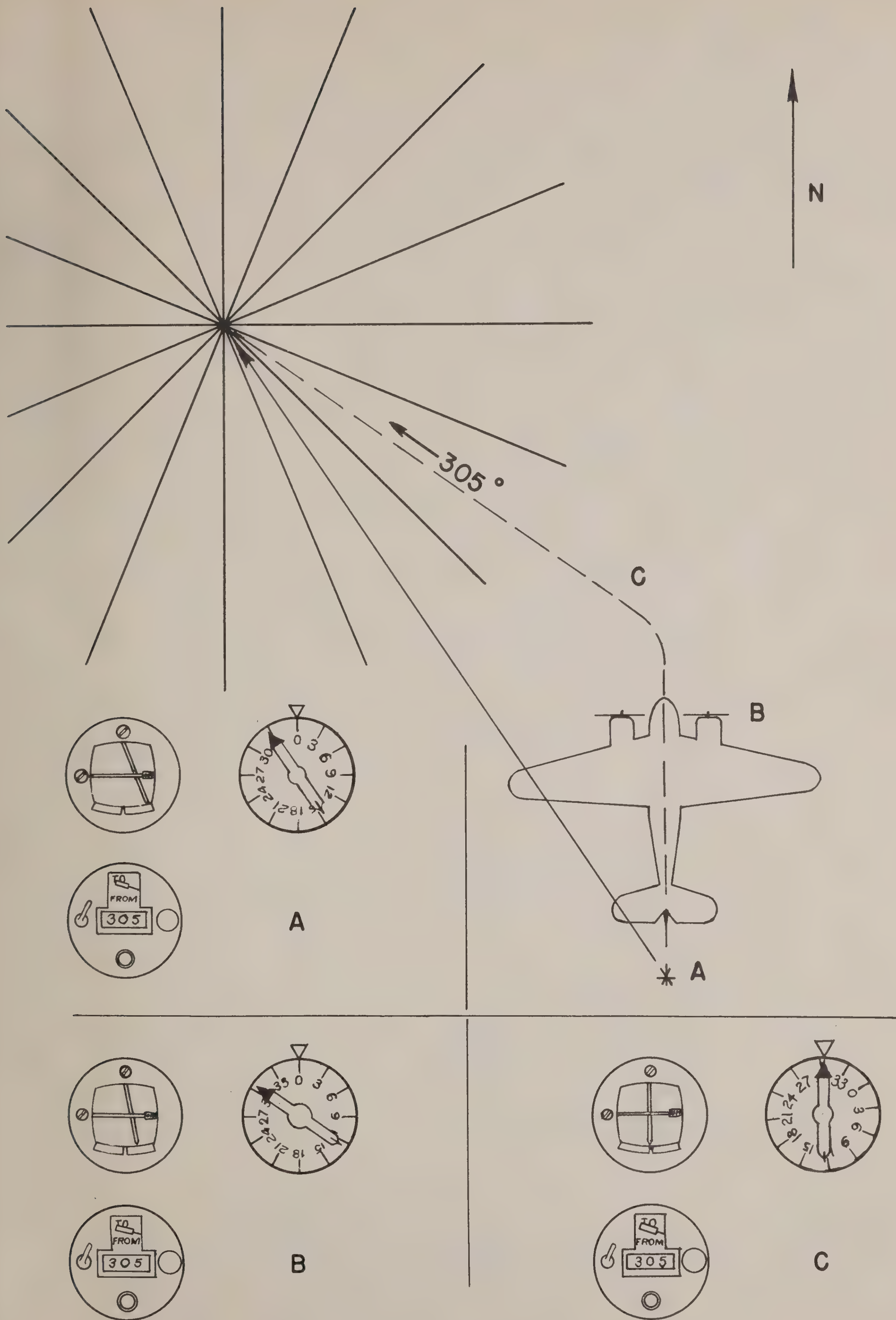


Figure 5 Typical Instrument Readings -
Flying Toward Radial 305

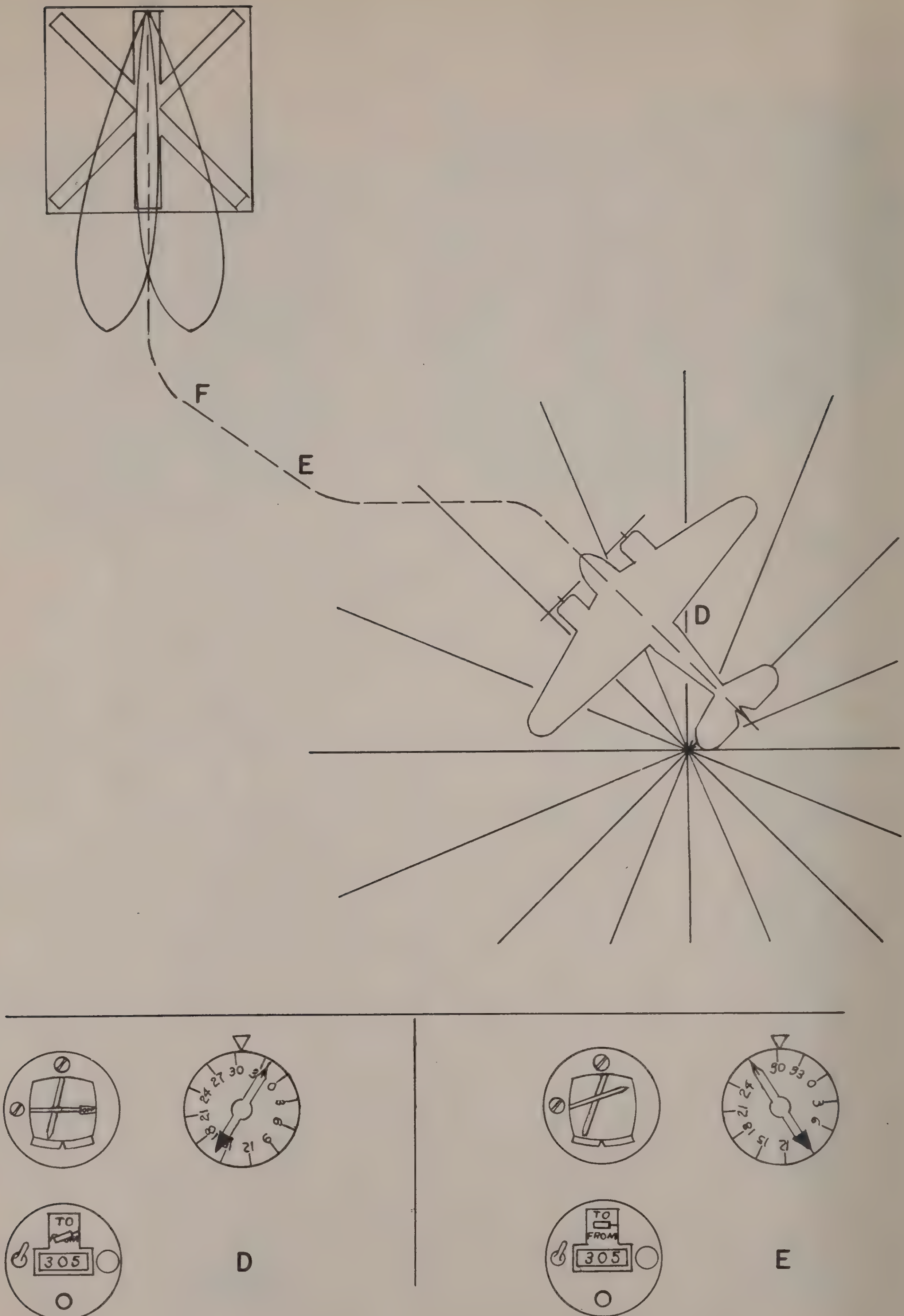
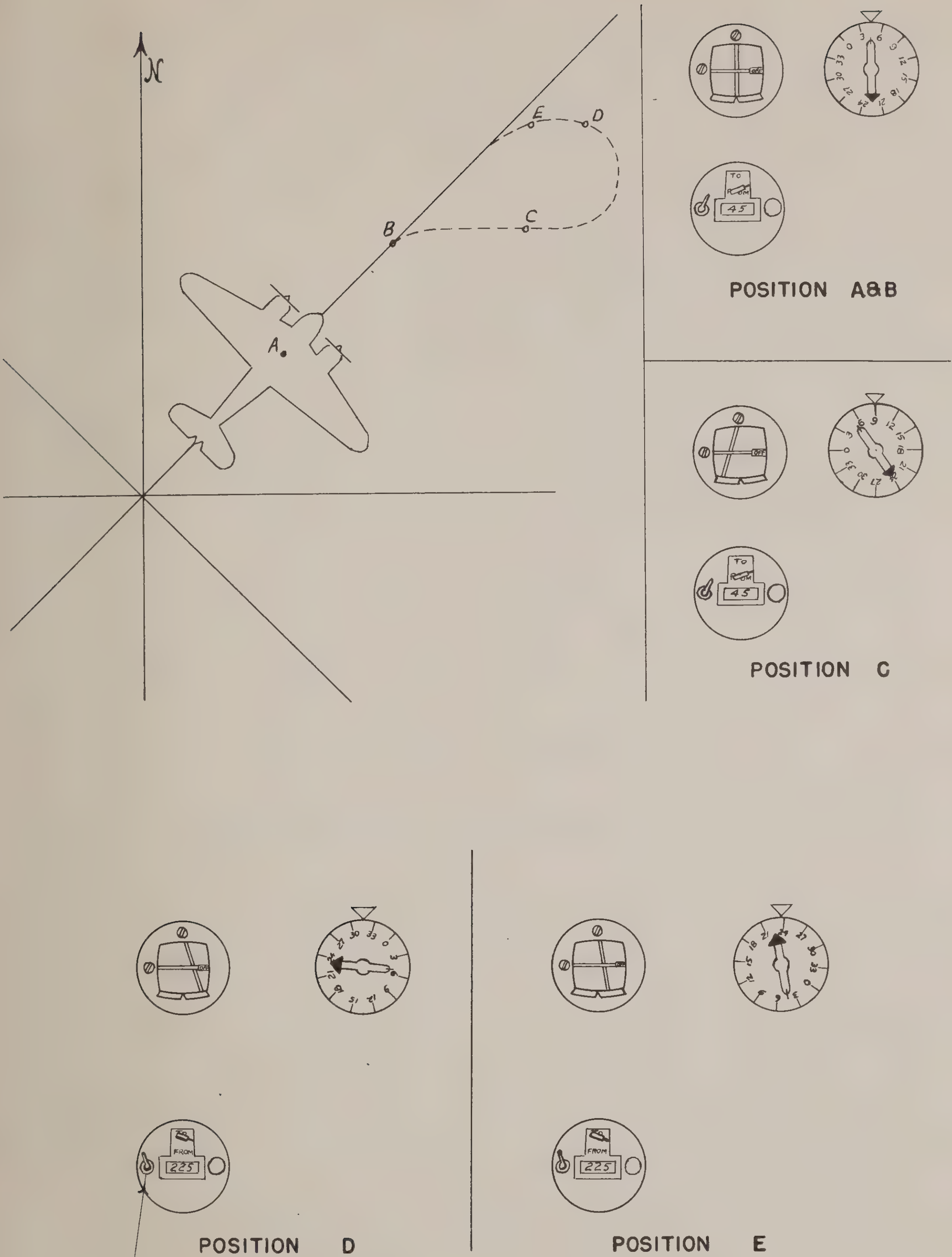


Figure 6 Typical Instrument Readings -
Passed Over Station on Track 305



NOTE: THIS SHUTTER SWITCH HAS BEEN THROWN TO THE LEFT TO REVERSE THE TRACK SELECTOR READING

Figure 7 Typical Instrument Readings - Turn After Passage Over Station

SECTION 1

GENERAL DESCRIPTION

1.1. GENERAL.

1.1.1. Purpose of equipment. - The Model 51R Navigation Receiver has been designed to fulfill the navigation and communication requirements of all types of military, commercial and private aircraft using the 108 to 136 mc band. Facilities are included for reception of all range, localizer, and voice signals in this portion of the vhf spectrum. The 51R Receiver covers the band 108 to 136 mc on a 100 kc channel separation basis. Any one of the 280 separate channels so obtained may be selected. The pilots selection is made by two dials, the readings of which are combined to read directly in frequency. The receiver, including instrumentation circuits, is mounted in a case of 1/2 ATR size. The power supply is external.

1.2. ELECTRICAL DESCRIPTION.

1.2.1. INSTRUMENTATION. - The 51R-1 Receiver provides instrumentation facilities for the following:

(a) Localizer - tone type (including flag alarm.)

(b) Localizer - phase type (including flag alarm.)

(c) Omnidirectional ranges - automatic indication through selsyn differential, giving combined ADF and magnetic compass presentation on radio magnetic indicator.

(d) Omnidirectional ranges - indicating on cross-pointer meter, course chosen by a manual bearing selector; includes operation of a TO-FROM indicator; flag alarm operated from reference phase channel.

The tone localizer functions of the receiver are straightforward and are comparable to those provided in the USAF RC-103 equipment now installed in many transport aircraft. Item (b) of the above list is a facility to permit the use of phase type localizers which are expected to come into general use within the next few years. Phase type localizers provide indications identical to those obtained from present day localizers.

The instrumentation of item (c) presents all information available from the omnidirectional range system. As a result of combining omnidirectional range and magnetic data through a differential unit, the pilot is provided with a pointer which reads heading to the station against a stabilized magnetic scale. This presentation is the same as is given by the present day automatic direction finder (ADF) with the addition of a stabilized magnetic scale.

The instrumentation in (d) is an aid in track flying in which a bearing selector is provided which permits the pilot to set up the range leg on which he wishes to fly. Flight directions from the selected leg are shown on a cross-pointer indicator. As a further aid to track flying, the TO-FROM indicator has been provided. The simplest way to understand this instrument is to think of it as a station marker which reads TO until you reach the station and switches over to FROM when the station has been passed. With the full automatic ADF type presentation in use, however, the TO-FROM indicator can be ignored, since the aircrafts location with respect to the station will be shown clearly and unmistakably by the action of the ADF type pointer on the radio magnetic indicator.

The voltages which actuate the cross-pointer indicator when flying on a selected track or range leg are of the character required to couple into the new type electronic automatic pilots, thus permitting automatic flight on any desired radial toward or away from the station.

The instruments used to provide the above indicated facilities are as follows:

a & b - Deviation Indicator provides localizer and glidepath indication, plus flag arm.

c - Omni-bearing Indicator comprises a servo motor driving a resolver and autosyn differential.

c - Radio Magnetic Indicator Collins type 332C-1 or Pioneer type 36101-1.

c - Flux-gate, or Gyrosyn Magnetic Compass equipment are available from Eclipse Pioneer Instrument or Sperry Gyroscope Companies.

d - Omni-bearing Selector including TO-FROM indicator.

1.2.2. RECEIVER. - The 51R Receiver is a double conversion superheterodyne having a tunable first i-f of 19.5 to 21.4 mc and a second fixed i-f of 3.2 mc. Injection frequencies for the first converter are obtained from a group of 14 crystals which are selected by a tap switch driven by the megacycle Autopositioner. This positioner tunes the crystal multiplier circuits as well as the four tuned circuits in the r-f amplifier which precedes the first converter. Injection frequencies for the second converter are supplied by a group of 20 crystals and are selected by a switch driven by the tenth-megacycle Autopositioner. The tenth-megacycle Autopositioner simultaneously tunes the second injection crystal multiplier circuit as well as the four tuned circuits associated with the first (tunable) i-f amplifier.

Tracing from the antenna, all signals received in the selected 2 mc band pass through a tuned circuit to an r-f amplifier, and thence through a

pair of tuned circuits to the first converter. The first converter is supplied with an injection voltage of suitable frequency to heterodyne the signal down to a frequency within the 19.5 to 21.4 mc band of the first i-f amplifier. The first i-f amplifier is tuned to the specific frequency desired and this frequency is thus selectively amplified and fed to the second frequency converter where it is mixed with an injection voltage obtained from the second crystal group. The output frequency of the second converter lies in the middle of the 3.2 mc second i-f amplifier pass-band, and is selectively amplified and passed to the detector.

Reduction of image is accomplished through suitable selection of intermediate frequencies and by the employment of three tuned circuits ahead of the first mixer and a tunable high frequency i-f amplifier ahead of the second mixer. Special attention has been given to the problem of rejecting interference from high power television and FM services. The receiver has been arranged so that in addition to the high image rejection, there is no point within the navigation coverage of the receiver at which image interference could be encountered from either the FM or television services.

Rejection of unwanted frequencies other than the image is accomplished by (1) adequate selectivity in both crystal multiplier systems, (2) careful choice of i-f and crystal frequencies, (3) the use of high Q tunable i-f transformers and (4) adequate shielding and bypassing of all circuits involved. The selectivity of the tunable i-f amplifier section is such as to provide considerable attenuation to adjacent channels and high attenuation to channels further removed in frequency. Thus, cross modulation is virtually eliminated from the second mixer. The aural output stage provides a maximum output level of 300 milliwatts into a 500 ohm circuit. Since interphone systems may require 50 milliwatts or less, the output of Z101, the high pass aural filter, will need to be tapped down. This is done by adjusting potentiometer R148, located in the grid circuit of the audio output amplifier.

The final selectivity required to insure adequate rejection of adjacent channel signals is provided by the second i-f amplifier which operates at 3.2 mc. The 3.2 mc i-f amplifier has a 6 to 60 db ratio of 45 - 150 kc, which, combined with the selectivity obtained in the first i-f amplifier gives overall rejection of 70 db to the adjacent channel under worst conditions of frequency drift of both receiver and transmitter. Assuming that both receiver and transmitter are operating on frequency, the adjacent channel rejection is 80 db.

The AVC system in the receiver employs a d-c amplifier to give the constant signal output required to insure accurate operation of the indicator system. A combined oscillator and rectifier is used to provide the negative voltage supply for the d-c amplifier circuit and for bias applications.

The detector is conventional and an improved series type noise limiter is included. This limiter is of the peak clipping type, which tends to give constant output at any percentage of modulation above the clipping threshold without loss if intelligibility. A tap on one of the frequency selector wafers in the receiver selects the proper audio gain setting for 30% modulated voice signals from navigation facilities, and 100% modulation signals delivered by communication stations. This level switching, combined with the inherent leveling action of the noise limiter, insures close control of audio output at the proper preselected level. A carrier-operated audio squelch is included in the receiver. The instrumentation system requires 26 volts 400 cps a-c.

1.2.3. REMOTE CONTROL SYSTEM. - The frequency control system permits the selection of any one of 280 channels, using 9 control wires in a re-entrant circuit. A motor drive positions either the 2 megacycle or the one-tenth megacycle selector shafts. This mechanism provides for the control of the two selector shafts from a single motor through a pair of over-running clutches and stop mechanisms. Switching time between any pair of frequencies varies from a minimum of 1/10 second to a maximum of 2 seconds. The controls which are provided for the pilot's use are calibrated directly in megacycles and tenths of a megacycle, so that the frequency of the selected channel is read directly from the concentric dials. The pilot's control unit has been arranged to control an associated glide path receiver and distance measuring equipment. The choice of phase or tone modulated localizer service is made by operation of a toggle switch on the remote control unit.

1.3. MECHANICAL DESCRIPTION.

1.3.1. RECEIVER. - The receiver, including r-f, audio, and indicator circuits, is mounted in a case of 1/2 ATR unit size. This is the same size as the Army-Navy JAN-C-172 type A-1-d. All connections with the exception of the antenna enter the receiver through a rear plug, cannon type DPD-45-34P. An extractor is provided on the shockmount to aid in installing and removing the receiver from its rear plug shockmount.

The 90 and 150 cycle filter, together with the resistors and potentiometers which comprise the audio circuits for tone localizers and two-course ranges, are mounted under a detachable cover fastened to the top rear of the receiver case. These components occupy a space immediately above the wiring trough which is associated with the rear plug mount. If the 90/150 cycle features are dropped from the localizer and two-course ranges at a later date, these components may be removed and discarded.

1.3.2. ACCESSORY UNIT. - Installation of the receiver with its associated instrumentation necessitates the inclusion of a number of related accessory items for which mounting provision must be made. The type 351A-1 accessory unit, which is 1/2 ATR in size, provides mounting space for two type 337A-1 Radial Converter Indicators, a maximum of three type 333B-1 Radio Magnetic Indicator

servo amplifiers and two type 416N-1 Dynamotor Power units for the receivers. This arrangement provides a compact and simple means of installing a group of miscellaneous items. Where a receiver is installed, with full instrumentation, it is recommended that an accessory unit be installed at the same time, thus readying the installation for future addition of a second navigation receiver without extensive revision of the original installation.

1.4. SPECIFICATIONS

1.4.1. BASIC FUNCTION. - To provide for reception of all aircraft communication and navigation services in the vhf region, betwe n 108 and 136 mc.

1.4.2. RECEIVER TYPE. - Double conversion superheterodyne.

1.4.3. INDICATING SYSTEM. - Facilities are provided for the following:

(a) Localizers, tone type, flag alarm.

(b) Localizers, phase type, flag alarm.

(c) Omnidirectional ranges, indicating on cross pointer meter, course chosen by radial selector; includes operation of TO-FROM indicator and flag alarm.

(d) Omnidirectional ranges, automatic indication through radial converter indicator, giving combined presentation on radio magnetic indicator. This automatic indication feature is operable simultaneously with the cross pointer indication mentioned in (c) above.

(e) The cross pointer meter circuits are designed to feed a load of 330 ohms which provides for a maximum of either three cross pointer meters, or two cross pointer meters plus a 1000 ohm load as presented by automatic flight control equipment.

1.4.4. INSTRUMENTATION.

(a) Flight Path Deviation Indicator - Weston Model 888.

(b) Omni-Bearing Selector - Collins Type 336A-1 (includes TO-FROM indicator)

(c) Omni-Bearing Indicator -Collins Type 337A-1.

(d) Radio Magnetic Indicator - Collins Type 332C-1.

1.4.5. REMOTE CONTROL SYSTEM. - Two deck, concentric tap switches, giving decade selection of frequencies. Nine control wires between cockpit and receiver for 280 channel selection. Control panel includes toggle switch to choose between phase and tone type localizers; this function requires

one additional wire. Basic design permits simultaneous control of glidepath and DME facilities.

1.4.6. FREQUENCY COVERAGE. - 108.0 - 135.9 mc.

1.4.7. CHANNELS. - 280 channels are provided, spaced at 100 kc intervals throughout the band.

1.4.8. SELECTIVITY, OVERALL. -

Total Band Width	Attenuation, DB
45 kc min.	6 db
150 kc max.	60 db

1.4.9. STABILITY. - 0.007% under all service conditions; i.e., from 0 to 95% humidity, from -55 to +72 degrees C., and with battery voltage varitions of ±10%.

1.4.10. UNDESIRED FREQUENCY RESPONSES. - Attenuation of undesired frequencies is as follows:

Image:	Receiver only	75 db
	Including antenna	100 db
Adjacent Channel:		75 db
All other undesired frequencies		80 db

1.4.11. RADIATION. - Radiation from the receiver is negligible; simultaneous parallel operation of receivers on a common antenna is permissable without interference.

1.4.12. SENSITIVITY. - Two microvolts or better to produce 200 milliwatts output at a signal-to-noise ratio of 6 db or better when the input signal is 30% modulated with a 1000 cycle tone. Screwdriver adjustment of sensitivity control is accessible thru front panel.

1.4.13. AUTOMATIC VOLUME CONTROL. - Flat within ±1 db from 5 microvolts to 100,000 microvolts input.

1.4.14. NOISE LIMITER. - Series diode peak clipping type.

1.4.15. SQUELCH CIRCUIT. - Carrier operated; preset threshold adjustment in receiver.

1.4.16. AURAL OUTPUT. - Single channel, 300 mw to 500 ohm circuit.

1.4.17. FIDELITY. - Within 6 db, 300 to 3500 cycles.

1.4.18. INPUT. - 52 ohms coaxial.

1.4.19. MECHANICAL. - 1/2 ATR case size (JAN A-1-d). All connections except antenna, enter receiver through rear plug; cannon type DPD-45-34P. Mechanical design of mounting includes extractor to ease separation of receiver from shockmount.

1.4.20. POWER SUPPLY. - Dynamotor power unit, 416N-1 or 416N-2, external to receiver; 28 volt dc supply standard; 14 or 28 volt operation optional through use of dual input type dynamotor, 416N-2.

D-C Power requirements: 5 amperes at 28 volts (416N-1 or 416N-2) or 11 amperes at 14 volts (416N-2)

A-C Power Requirements: 0.2 ampere, 26 volts, 400 cycles a-c, for full automatic instrumentation.

1.4.21. ACCESSORY UNIT. - Type 351A-1, 1/2 ATR case providing mounting space for two omni-bearing indicators, Type 337A-1; a maximum of three RMI servo amplifiers, type 333B-1, together with a maximum of 2 dynamotor power supply units, Type 416N-1. This unit is wired ready to receive the accessories mentioned, and all connections are brought in through a standard cannon DPD-45-34P rear plug. Mechanical design of mounting includes extractor to ease separation of accessory unit from shockmount.

1.4.22. WEIGHT. - The weights of the various system units are as follows:

Receiver, Type 51R-1	24 lbs.
Shockmount for 51R-1	3 lbs.
Accessory Unit, Type 351A-1	7.2 lbs.
Shockmount for 351A-1	3 lbs.
Antenna, Type 37J	5 lbs.
Power Supply, Type 416N-1	6 lbs.
Power Supply, Type 416N-2	10.6 lbs.
Control Box, Type 314U-1	0.7 lbs.
Flight Path Deviation Indicator, Type ID-48/ARN	1.87 lbs.
Omni-bearing Selector, Type 336 A-1	2 lbs.
Omni-bearing Indicator, Type 337 A-1	2.5 lbs.
Radio Magnetic Indicator, Type 332 C-1 (Flux Gate or Gyrosyn Transmitter, Amplifier and Master Indicator - Supplied by Sperry or Pioneer)	2 lbs.
Gyrosyn, including flux valve Flux-gate installation	8 lbs.

1.4.23. TUBE TYPES - 5654 (modified 6AK5) and 5670. These tubes are included in the airlines-military long life program.

1.4.24. STABILITY OF INDICATING CIRCUITS. - Within 0.5 degree under any of the following conditions:

(a) Reference voltage change of ±25%.
(b) Variable voltage change of ±25%
(c) Reference and variable voltages simultaneously changed ± 25%.
(d) Receiver input from 10 to 100,000 microvolts.
(e) Temperature range from - 55 to +72 degrees C.
(f) Battery voltage variation of ±10%.

1.4.25. TRACKING ERROR. - Within ±3/4 degree under standard conditions.

SECTION 2

INSTALLATION

2.1. INSTALLATION.

2.1.1. PRELIMINARY.

(a) Unpacking. - The shipping carton is marked with arrows to indicate the upright position. Remove all packing material and lift unit out carefully. Inspect unit for apparent damage, loose screws or bolts. Be certain all controls, such as, switches, knobs, etc., work properly. All claims for damage should be filed promptly with the transportation company. If a claim for damage is to be filed, the original packing case and material must be preserved.

2.1.2. GENERAL.

(a) TYPES OF INSTALLATION. - The purpose of this section of the instruction book is to familiarize you with different types of installation that are possible with the 51R-1 Navigation Receiver and its accessories.

(1) Minimum Instrumentation Installation. - Refer to figure 2-1. This illustration shows a typical installation with a 51R-1 Receiver and instruments and gives some idea of the cabling required for this type of installation. This type of installation may be required for certain types of air service.

(2) Full Instrumentation Installation. - Refer to figure 2-2. Two receivers, two sets of instruments and one accessory unit are provided. It should be understood that with either a two or three instrument installation that it is not necessary to use a separately mounted (416N) power supply. If it is desired to use the accessory unit (351A-1) then the (416N) power supply will be mounted inside the accessory unit.

(3) Installation Procedure, Mechanical.

a Receiver Mounting (51R-1). - Refer to figures 2-3 and 2-4. These drawings give the outline and mounting dimensions of the receiver dust cover and the shockmount. When mounting the receiver, the minimum clearance on the sides should be two inches and a minimum of 4 inches should be allowed in front and rear of the unit. This allows the receiver to be removed with ease and allows space for cables in the rear.

b Accessory Unit Mounting (351A-1) - Refer to figures 2-4 and 2-5. These illustrations give the outline and mounting dimensions of the Accessory Unit and the shockmount. The shockmount is the same as that for the receiver except for the connector plug. The Accessory Unit should be mounted beside the receiver for convenience in wiring. A minimum of two inches should be allowed on both sides of the accessory unit for free swing on the shockmount,

A minimum of four inches should be allowed in front and in the rear of the accessory unit. This allows removal of the accessory unit from the shockmount and allows enough space in the rear for the interconnecting cable.

c Power Supply Mounting (If used in place of Accessory Unit) (416N). - Refer to figures 2-6, 2-7 and 2-8. These illustrations give the outline and mounting dimensions of the 416N Power Supply. A clearance of 5/8" is required at the top of the power supply to facilitate the removal of the unit from the base. A clearance of approximately 4 inches is required for removal of the power plug from the supply.

d Servo Amplifier (333B-3). - Refer to figure 2-10. The servo amplifier has two possibilities for mounting. If an Accessory Unit 351A-1 is used, the servo amplifier will be mounted in the accessory unit as shown in figure 2-5. However, if no accessory unit is employed then the servo amplifier can be mounted in any convenient out-of-the-way place.

e Frequency Control Unit Mounting (314U-1.) - Refer to figure 2-9. This illustration shows the dimensions of the cutout required to receive the control unit.

f Instrument Mounting. - All instruments should be mounted in convenient places on the instrument panel.

1 Deviation Indicator (ID-48). - Refer to figure 2-11. This illustration gives all necessary information for mounting.

2 Omni-bearing Selector (336A-1). - Refer to figure 2-12. This illustration gives all information necessary for mounting.

3 Omni-bearing Indicator (337A-1). - Refer to figure 2-13. This illustration gives all information necessary for mounting.

4 Radio Magnetic Indicator (332C-1). - Refer to figure 2-14. This illustration gives all information necessary for mounting.

(4) Antenna Installation. - The 51R Navigation Receiver, designed to receive every 100 kc frequency between 108 and 136 mc has a 52 ohm input. The 37J Deerhorn Antenna is designed to receive horizontally polarized waves from 108 to 122 mc with a 52 ohm coaxial output. Vertically polarized waves from 118 to 136 mc should be brought in to the receiver from a vertical antenna, such as the familiar AN-104.

Best localizer and omni-range reception for minimized propellor modulation and course pushing effects is obtained with the 37J Antenna mounted

atop the vertical rudder, as proved by experimentation. These experiments did not go into the results of severe icing conditions, nor static discharge effects. The second best place for the antenna is atop the fuselage over the cockpit but tail shadow causes nearly 19 db. signal strength attenuation. The 37J is mechanically interchangeable with the USAAF AS/27A ILS Deerhorn antenna. The maximum standing wave ratio it causes due to impedance mismatch at the frequency extremes is 5 to 1.

Because the Collins 37J Antenna does not provide for glide path reception, the Collins 37P Antenna is recommended. This antenna has a 52 ohm coax. receptacle which will connect to an R-89B/ARN-5 Receiver with 52 ohm coaxial cable into the receiver's twin lead receptacle. The 37P has an increase in voltage pick-up strength of 6 to 10 db. over the dipole on the AS/27A. Tests show that the impedance mismatch caused by connecting to the 100 ohm twin lead receptacle (with one side grounded) of the R89B with a 52 ohm coax cable is no greater than that obtained with 90 ohm twin lead so that all of the 6 to 10 db. increase is realized.

The 37P was designed to mount horizontally $\pm 30^\circ$ on the nose of the aircraft with its 52 ohm coax receptacle protruding through the mounting surface inside the skin of the ship.

(5) Installation Procedure, Electrical.

a Receiver Connections. - Refer to figures 2-17 and 2-18.

CAUTION

The wiring cable should have enough slack to permit free movement on the shockmount.

b Accessory Unit Connections. - Refer to figures 2-19 and 2-20.

CAUTION

The wiring cable should have enough slack to permit free movement on the shockmount.

c Power Supply Connections. - Figure 2-24 shows the schematic of the 416N-1 Power Supply for use with 28 volt d-c supply. The separate mounting base shown is for use when the 416N-1 is not mounted in Acessory Unit 351A-1.

The 416N-2 Power Supply, refer to figure 2-25, is intended for use with 14 volt d-c aircraft supply, but may also be used with 28 volt d-c source. The 416N-2 plug connections are electrically interchangeable with the 416N-1 (separately mounted.) The 416N-2 is not adapted to mounting on the 351A-1 Accessory Unit.

d Servoamplifier (333B-1 and 333B-3). - Refer to figure 2-26. This illustration shows the connections necessary for the servoamplifier. When used with a separate mounting base, the 333B-1 is designated as 333B-3.

e Remote Control Unit (Type 314U-1). - Refer to figure 2-23.

f Instrument Connections.

(1) Deviation Indicator (ID-48), - Refer to figure 2-11. The loading for the cross pointer circuits should be maintained at 333 ohms on the vertical needle circuit and 250 ohms on the flag alarm circuit. Compensation should be used if necessary to maintain these values.

(2) Omni-bearing Selector (336A-1). - Refer to figure 2-12.

(3) Omni-bearing Indicator (337A-1). - Refer to figure 2-13.

(4) Radio Magnetic Indicator (332C-1). Refer to figure 2-14.

To simplify the service problem, when more than one type of RMI is used, the RMI servo amplifiers have been made identical and an auto transformer has been designed to match the EIZ motor winding of Pioneer RMI Type 36101. Figure 2-27 shows the autotransformer and the adapter cable that make the RMI's interchangeable. This hookup necessitates a change in the Kearfoot RMI consisting of lifting the internal ground from pin V.

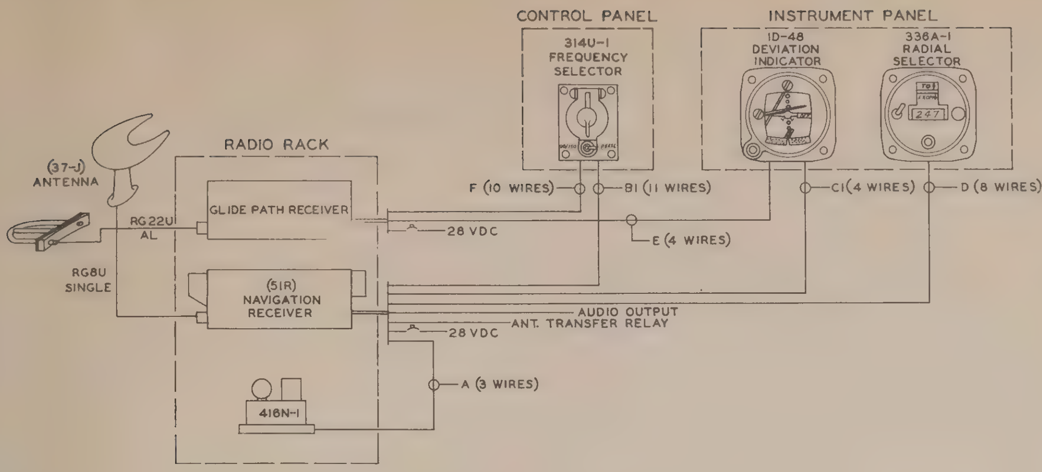
(g) Antenna Connection. - Antenna connections are made with coaxial lines from antenna to receiver.

(h) Connecting to Airplane Primary Voltage Source. - Four hundred cycle power supplied to the accessory unit should preferably come from an autotransformer. An alternate arrangement can be used where the autotransformers in the 333B-1 amplifiers supply the RMI servo motor and also one autosyn indicator rotor. The 28 volt windings on the 333B-1 autotransformers have a rating of 235 ma at 28v. Power requirements for autosyn indicator rotors and RCI motor and RMI motor are as follows: (approximate values)

Autosyn indicator rotor - 100 ma

RCI motor - - - - - - - - 150 ma

RMI motor - - - - - - - - 150 ma



CABLE KEY

POWER CABLE
28 V DC
250 DC B+
GROUND

FREQUENCY CONTROL - NAV. REC.
9 - WIRES FC.
TONE-PHASE LOCALIZER
GROUND

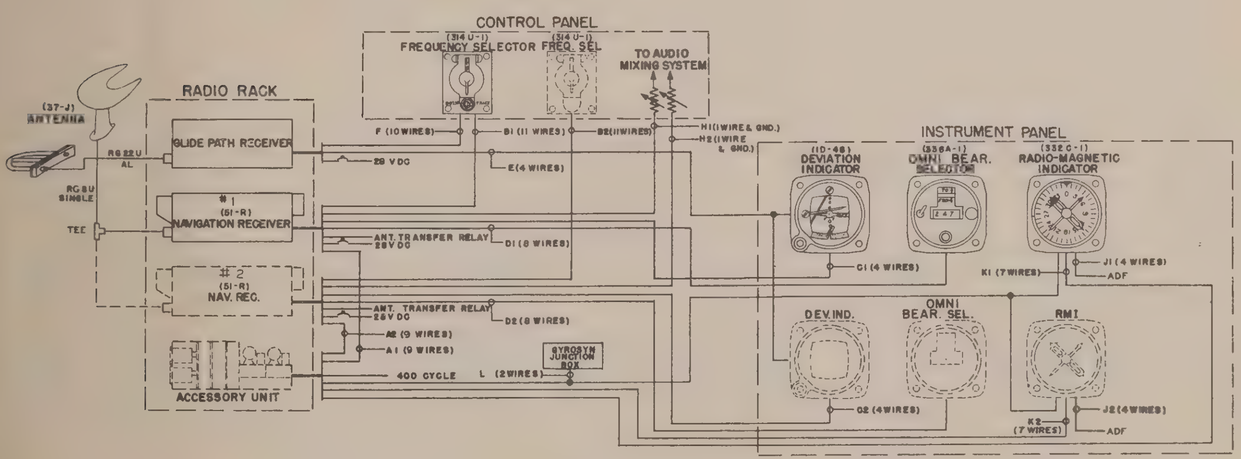
C - DEVIATION INDICATOR - NAV. REC.
LOC - POINTER
LOC - POINTER
FLAG ALARM
FLAG ALARM

D - OMNI BEARING SELECTOR
AMBIGUITY METER
AMBIGUITY METER
RADIAL SEL. STATOR } TWISTED PAIR
RADIAL SEL. STATOR }
RADIAL SEL STATOR } TWISTED PAIR
RADIAL SEL STATOR }
RADIAL SEL ROTOR } TWISTED PAIR
RADIAL SEL ROTOR }

E - DEVIATION INDICATOR - GLIDE PATH REC.
GLIDE PATH POINTER
GLIDE PATH POINTER
FLAG ALARM
FLAG ALARM

F - FREQUENCY SELECTOR - GLIDE PATH REC.
CHANNEL SELECTOR WIRES (10)

Figure 2-1 Navigation System, Minimum Instrumentation



LE A ACCESSORY UNIT TO NAV. REC.
28 V DC
B+
GROUND
MOTOR PHASE
MOTOR PHASE
OMNI BEARING INDICATOR STATOR } TWISTED PAIR
OMNI BEARING INDICATOR STATOR }
OMNI BEARING INDICATOR ROTOR } TWISTED PAIR
OMNI BEARING INDICATOR ROTOR }

LE B FREQUENCY SELECTOR TO NAV. REC.
FREQUENCY CONTROL WIRES (10)
TONE-PHASE LOC. SW.

LE C DEVIATION IND. TO NAV. REC.
LOC. POINTER
LOC. POINTER
FLAG ALARM
FLAG ALARM

LE D OMNI BEAR. SELECTOR TO NAV. REC.
AMBIGUITY METER
AMBIGUITY METER
OMNI BEARING SEL. STATOR } TWISTED PAIR
OMNI BEARING SEL. STATOR }
OMNI BEARING SEL. STATOR } TWISTED PAIR
OMNI BEARING SEL. STATOR }
OMNI BEARING SEL. ROTOR } TWISTED PAIR
OMNI BEARING SEL. ROTOR }

CABLE E DEVIATION INDICATOR TO GLIDE PATH REC.
GLIDE PATH POINTER
GLIDE PATH POINTER
GLIDE PATH FLAG ALARM
GLIDE PATH FLAG ALARM

CABLE F FREQUENCY SELECTOR TO GLIDE PATH REC.
CHANNEL SELECTOR WIRES (10)

CABLE H NAV. REC. TO AUDIO MIXING SYSTEM
AUDIO LINE *

CABLE J RMI TO ADF
ADF AUTOSYN STATOR
ADF AUTOSYN STATOR
ADF AUTOSYN STATOR & ROTOR COMMON
ADF AUTOSYN ROTOR

CABLE K ACCESSORY UNIT TO RMI
VHF ADF AUTOSYN STATOR
VHF ADF AUTOSYN STATOR
26 V 400 CYCLE-ROTOR
GROUND
MOTOR PHASE
MOTOR PHASE
MAGNETIC FOLLOW UP SIGNAL

CABLE L ACCESSORY UNIT TO RMI
GYROSYN STATOR
GYROSYN STATOR

NOTES:
1. No provisions shown for RMI or deviation Ind. Switching
2. No provisions shown for ON-OFF switching
3. Automatic Radio Flight Control (for landing or enroute flying) Connects to receiver output circuits in parallel with deviation indicators.
4. Accessory unit to contain:
   Omni bearing indicators
   Dynamotors
   Space available for 3 RMI dial drive servo amplifiers if required
5. 400 cycle must be from same source as gyrosyn compass
6. Wires marked with * tenatively shielded
7. No wiring shown for instrument lighting
8. Antenna transfer wire open circuit below 122 mc. energized (+26 V) 122 MC. and above.

Figure 2-2 Navigation System, Full Instrumentation

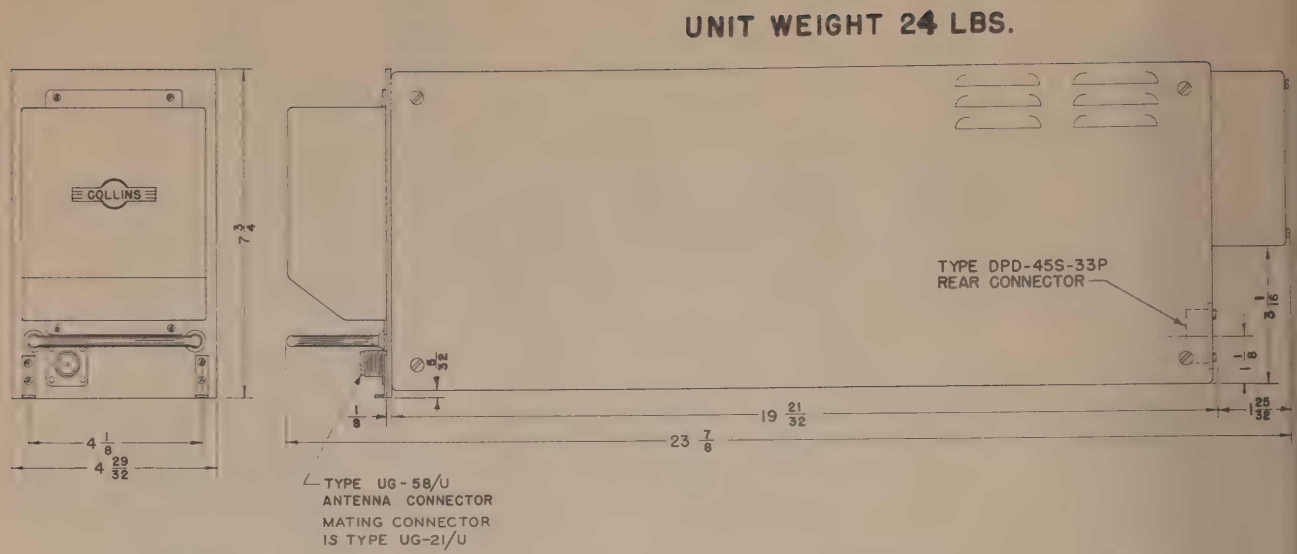


Figure 2-3 51R Navigation and Communication Receiver (Outline)

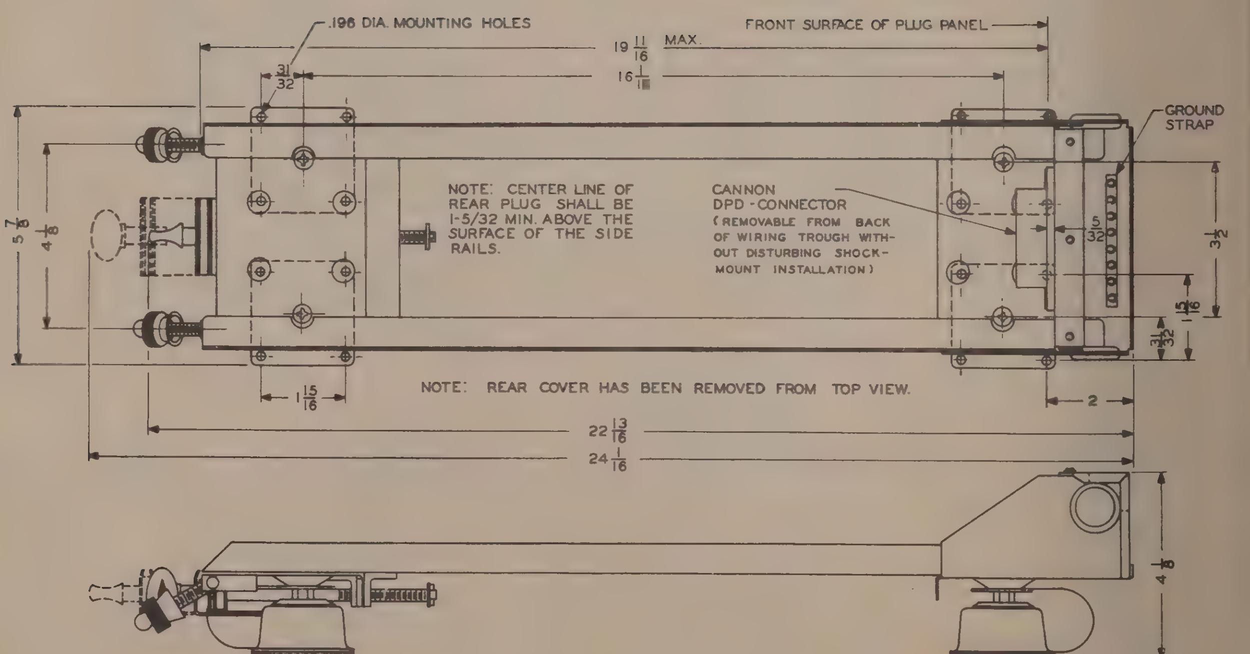


Figure 2-4 Shock Mount

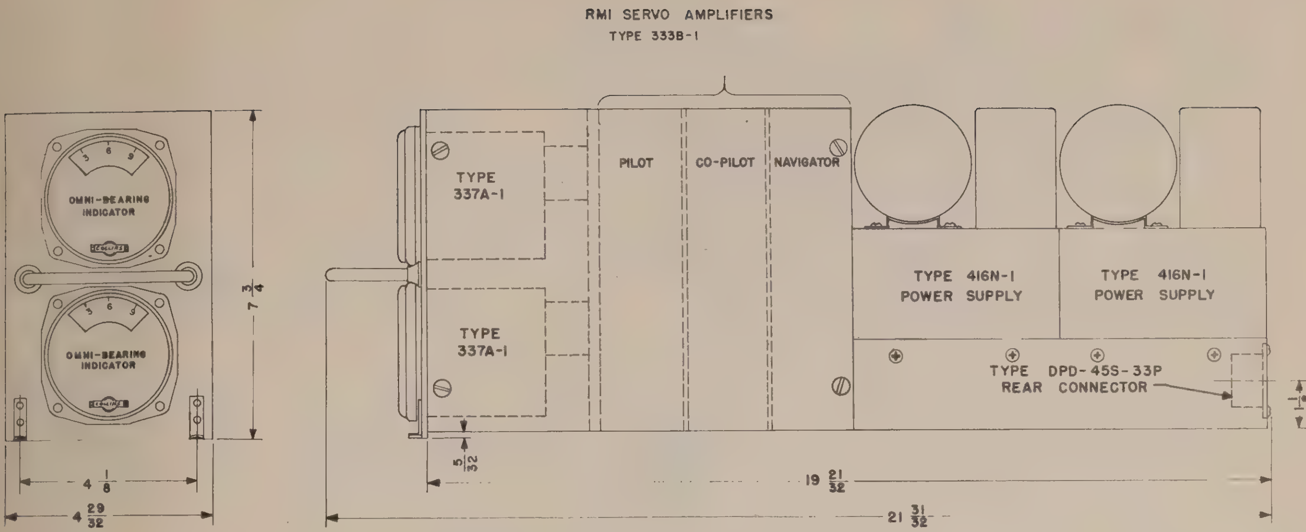


Figure 2-5 351A-1 Accessory Unit

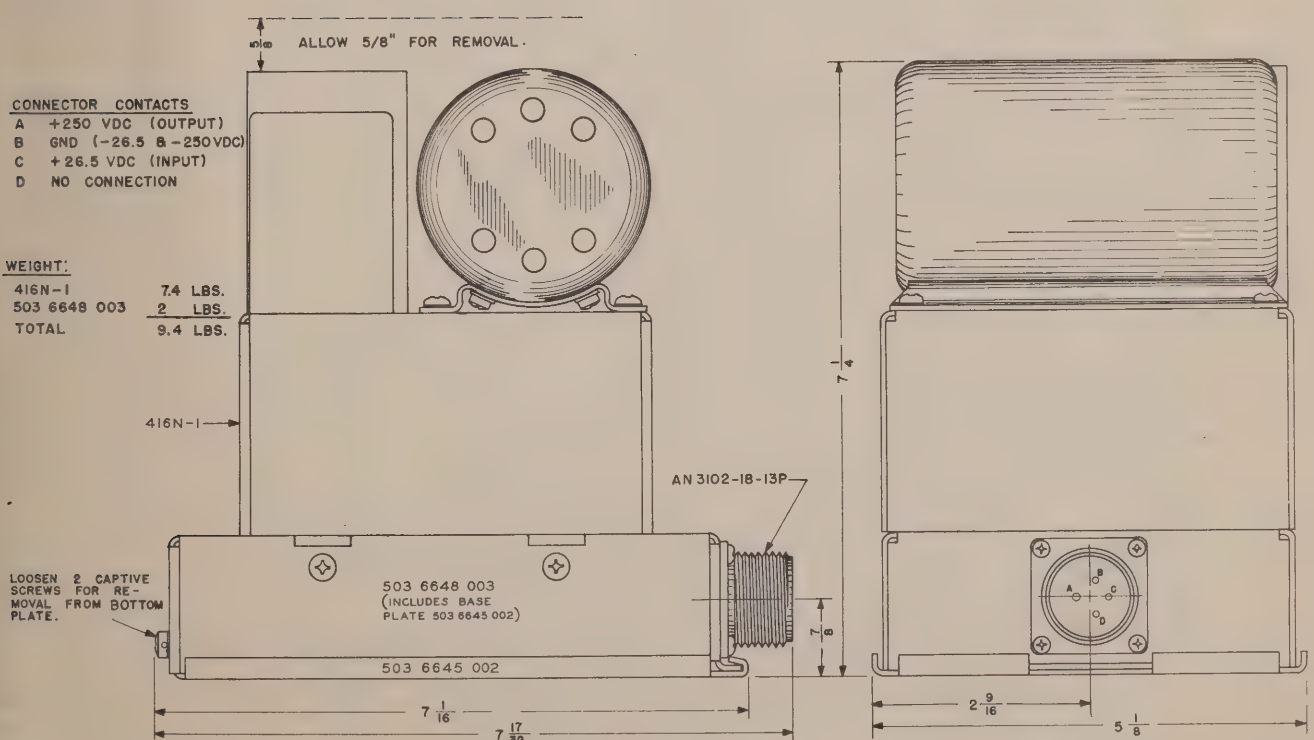


Figure 2-6 416N-1 Power Supply and 503 6648 003 Mounting Base

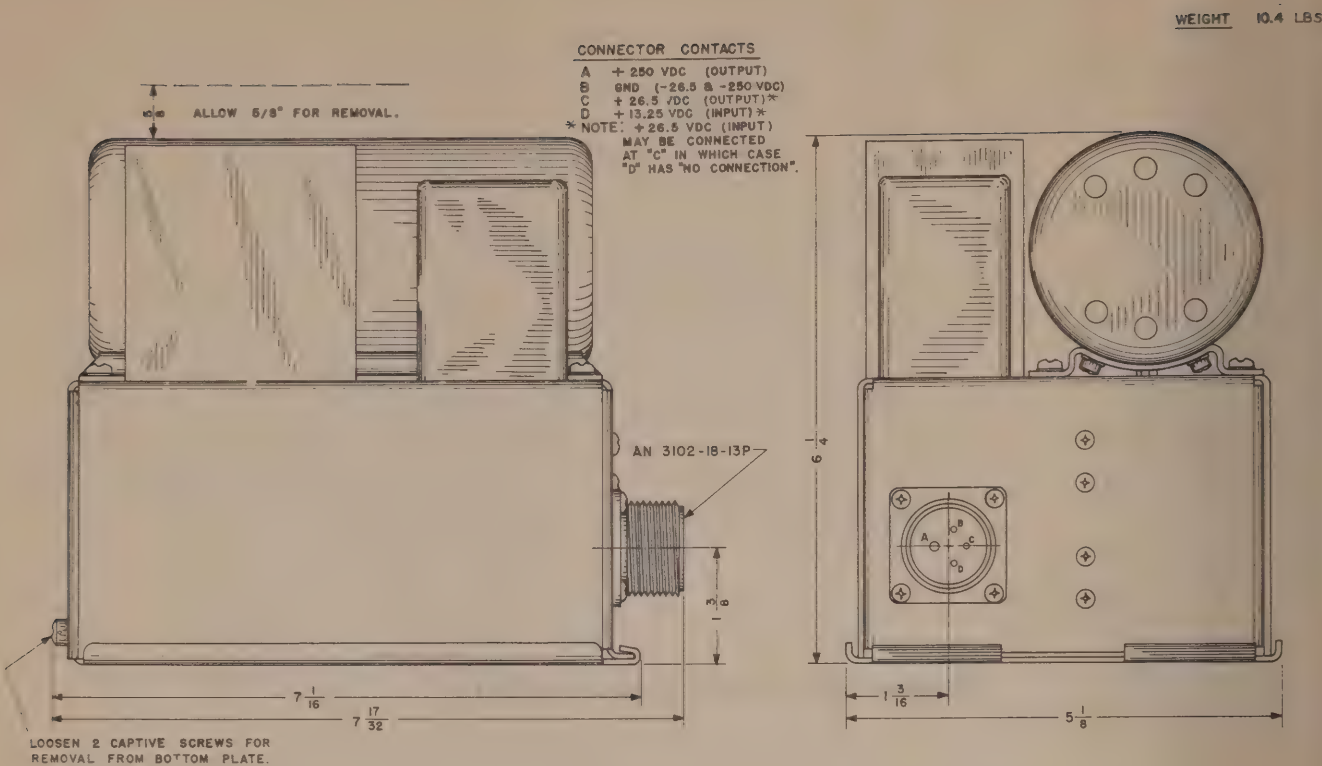


Figure 2-7 416N-2 Power Supply (Outline)

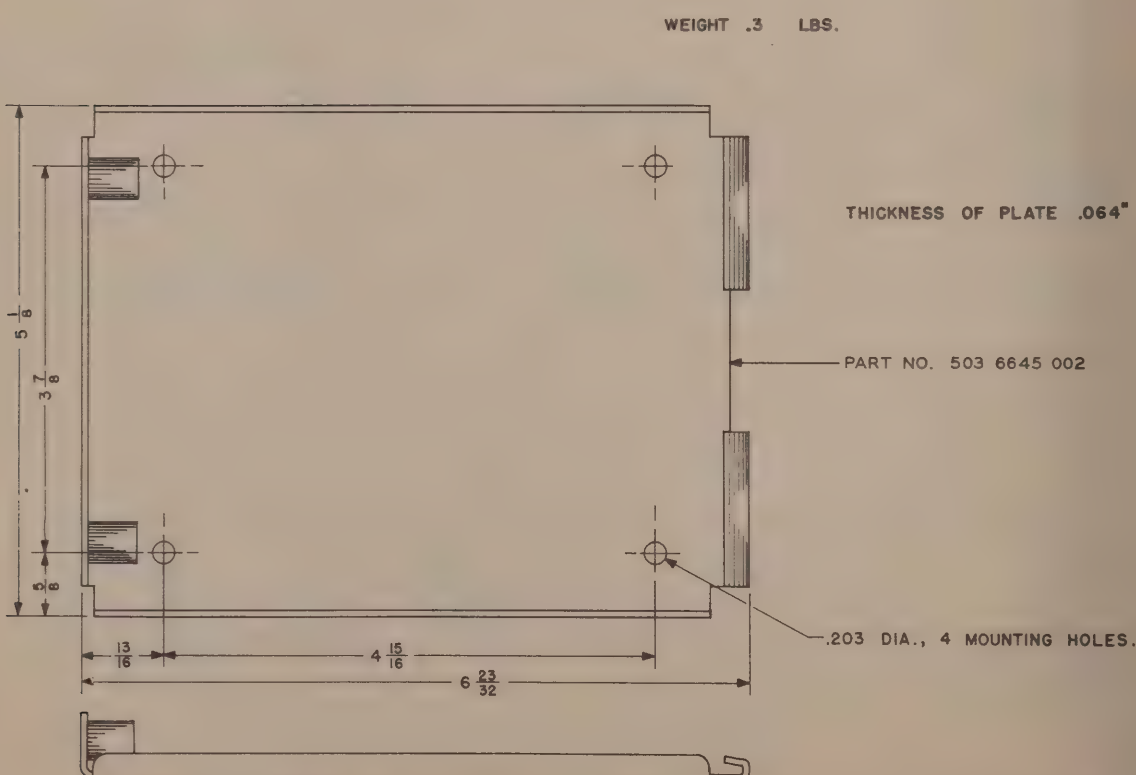


Figure 2-8 Bottom Plate for Mounting Base or 416N-2 Power Unit

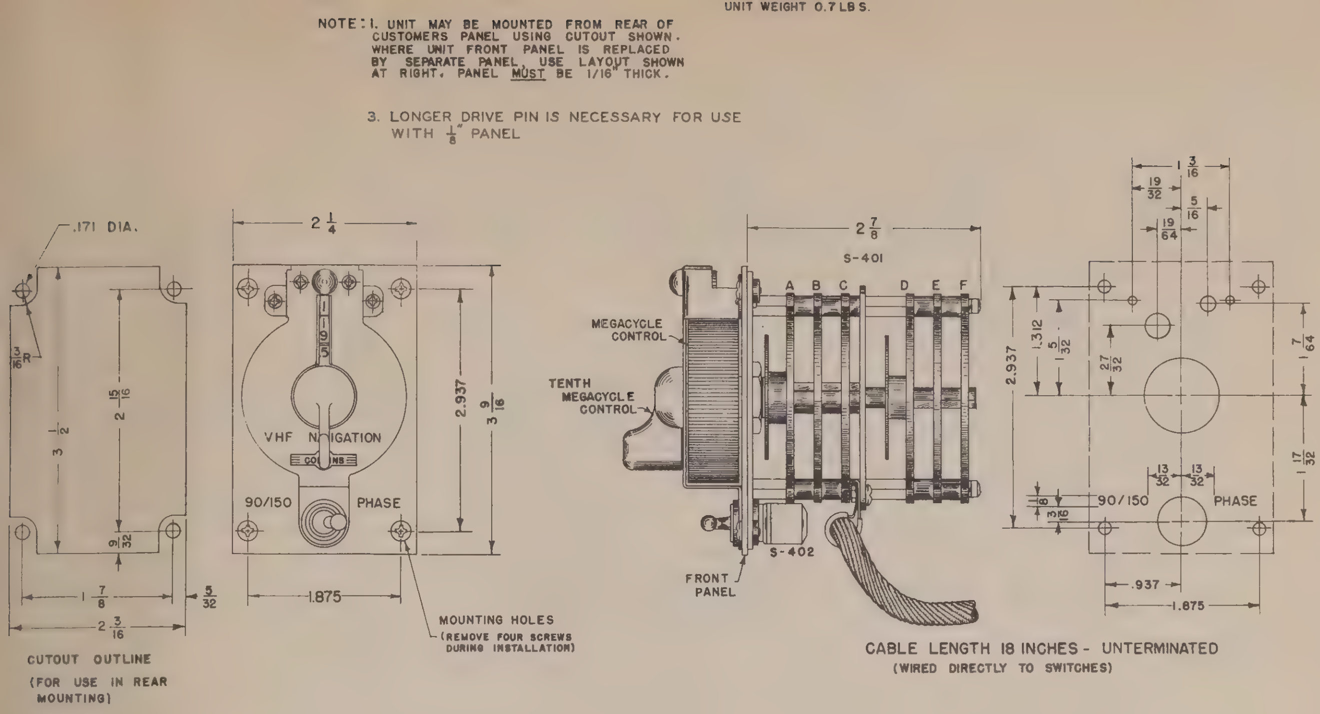


Figure 2-9 314U-1 Frequency Control Unit

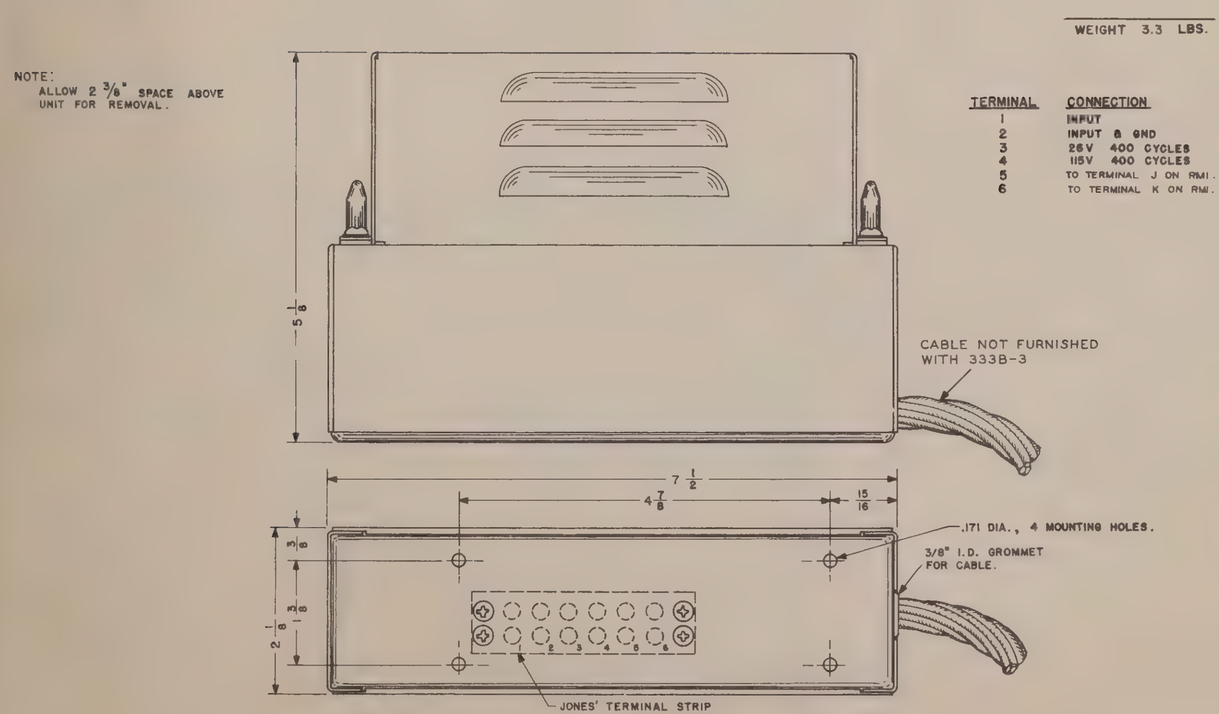
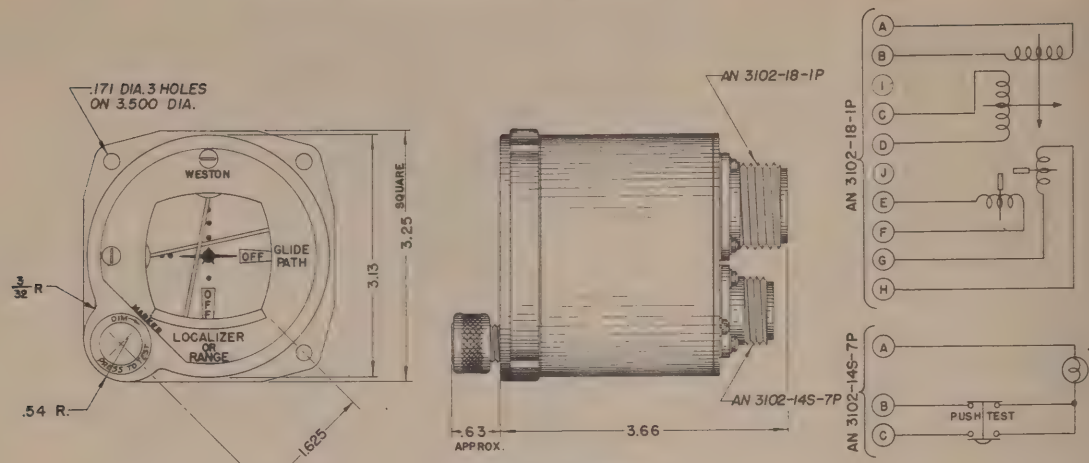


Figure 2-10 333B-3 Amplifier (Outline)

UNIT WEIGHT 1.87 LBS.

REAR CONNECTOR	MATING CONNECTOR A-N NO.	MATING CONNECTOR COLLINS NO.	CABLE CLAMP A-N NO.	CABLE CLAMP COLLINS NO.
AN-3102-18-1P	AN-3106-18-1S	357 4012 00	AN 3057-10	357 8004 00
AN-3102-14S-7P	AN-3106-14S-7S	357 4013 00	AN 3057-6	357 8002 00



NOTE: ALLOW 2 3/8" MINIMUM BEYOND REAR EDGE OF AN 3102-18-1P CONNECTOR FOR MATING CONNECTOR, CLAMP & CABLE BEND

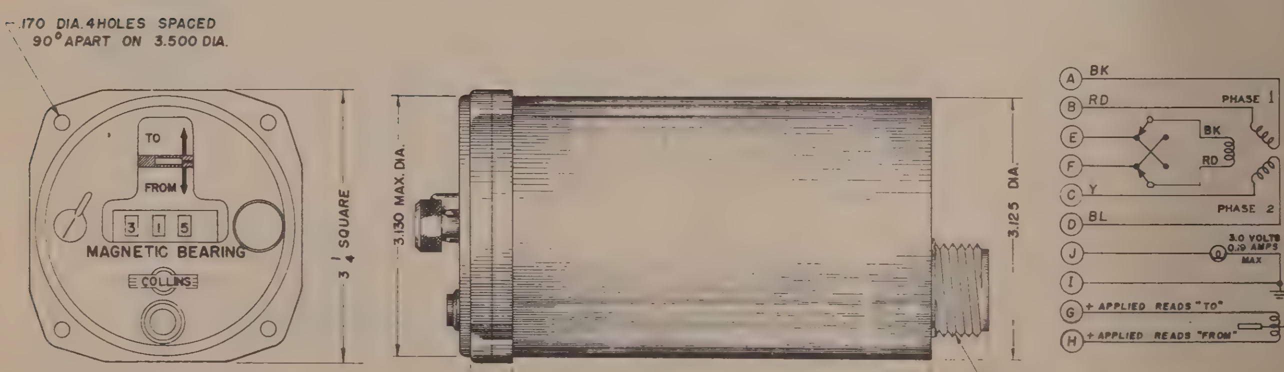
WIRING TO 10 PIN RECEPTACLE

MECHANISM	RECEPTACLE PINS +	RECEPTACLE PINS −	DEFLECTION
LOCALIZER	A	B	RIGHT
GLIDE PATH	C	D	DOWN
VERTICAL FLAG	E	F	RIGHT
HORIZONTAL FLAG	G	H	UP

Figure 2-11 Deviation Indicator (Weston Model 888, Type 3)
(U.S. Air Forces Type ID-48AF/ARN)

UNIT WEIGHT 2 LBS.

REAR CONNECTOR	MATING CONNECTOR A-N NO.	MATING CONNECTOR COLLINS NO.	CABLE CLAMP A-N NO.	CABLE CLAMP COLLINS NO.
AN3102-18-1P	AN3106-18-1S	357 4012 00	AN3057-10	357 8004 00



1/2 4 29/32 23/32

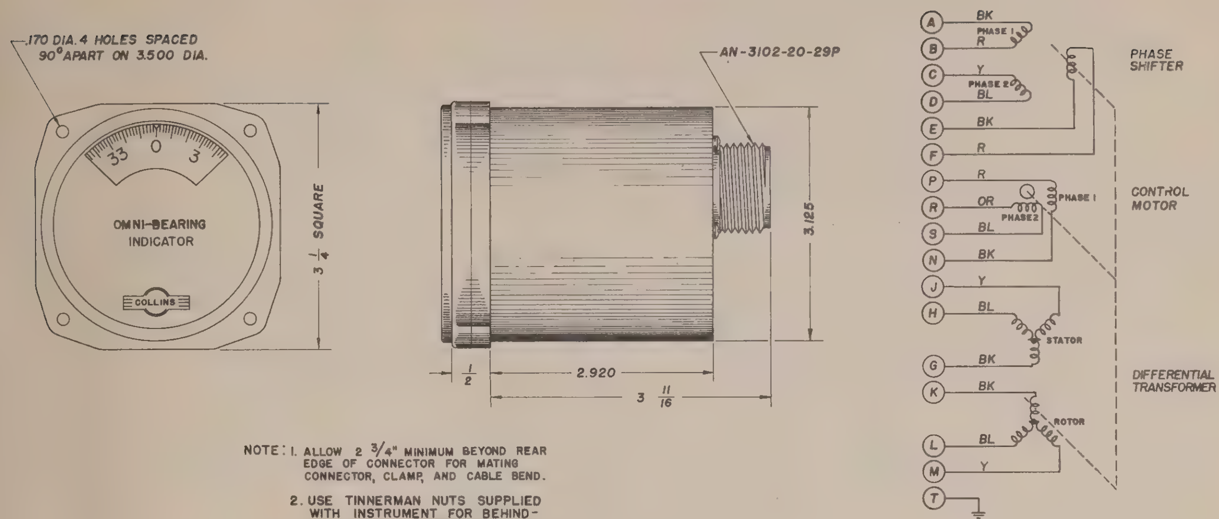
AN-3102-18-1P

1. WITH SWITCH IN CLOCKWISE POSITION THE BK ROTOR LEAD IS CONNECTED TO (E).
2. USE TINNERMAN NUTS SUPPLIED WITH INSTRUMENT FOR BEHIND-THE-PANEL MOUNTING.
3. ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

Figure 2-12 336A-1 Omni-Bearing Selector

UNIT WEIGHT 2.5 LBS.

REAR CONNECTOR	MATING CONNECTOR A-N NO.	MATING CONNECTOR COLLINS NO.	CABLE CLAMP A-N NO.	CABLE CLAMP COLLINS NO.
AN-3102-20-29P	AN-3106-20-29S	357 4004 00	AN-3057-12	357 8005 00



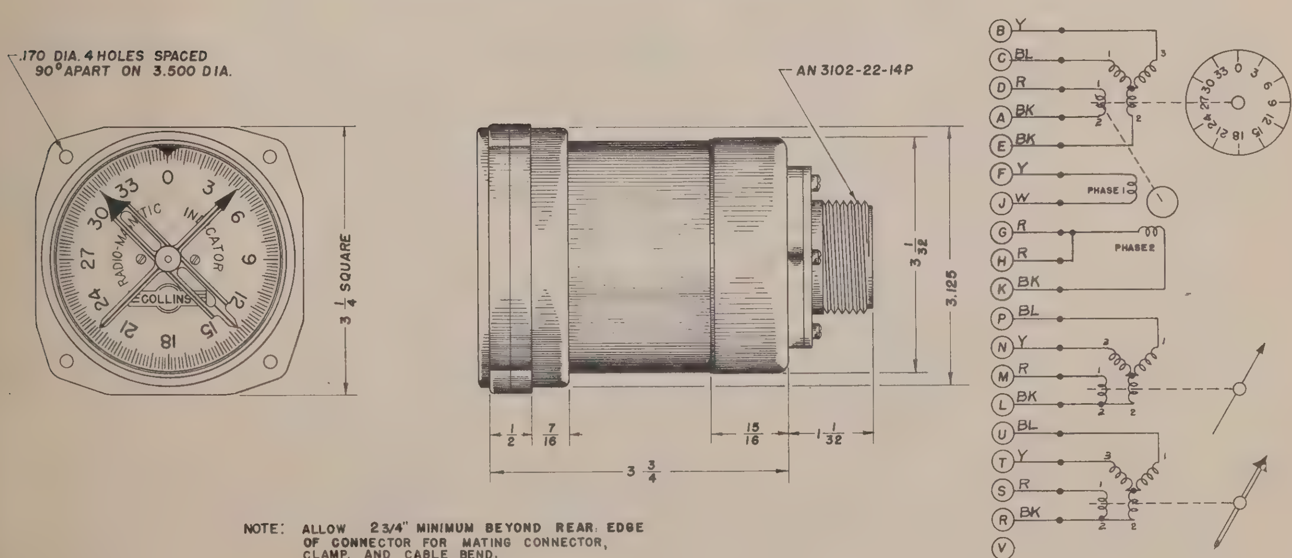
NOTE: 1. ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

2. USE TINNERMAN NUTS SUPPLIED WITH INSTRUMENT FOR BEHIND-THE-PANEL MOUNTING.

Figure 2-13 337A-1 Omni-Bearing Indicator

UNIT WEIGHT 2 LBS.

REAR CONNECTOR	MATING CONNECTOR A-N NO.	MATING CONNECTOR COLLINS No.	CABLE CLAMP A-N NO.	CABLE CLAMP COLLINS NO.
AN-3102-22-14P	AN-3106-22-14S	357 4005 00	AN-3057-12	357 8005 00



NOTE: ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

Figure 2-14 332C-1 Radio Magnetic Indicator

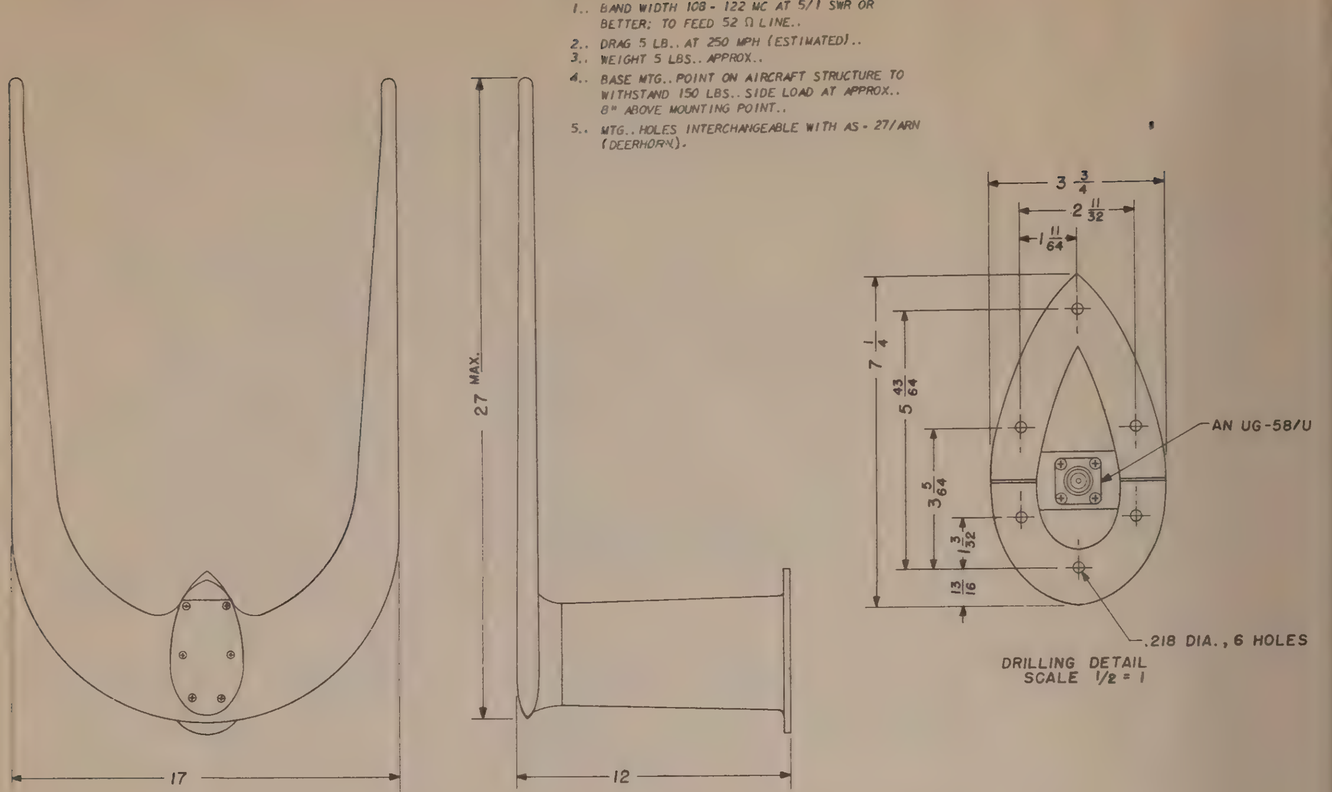


Figure 2-15 Type 37J Antenna

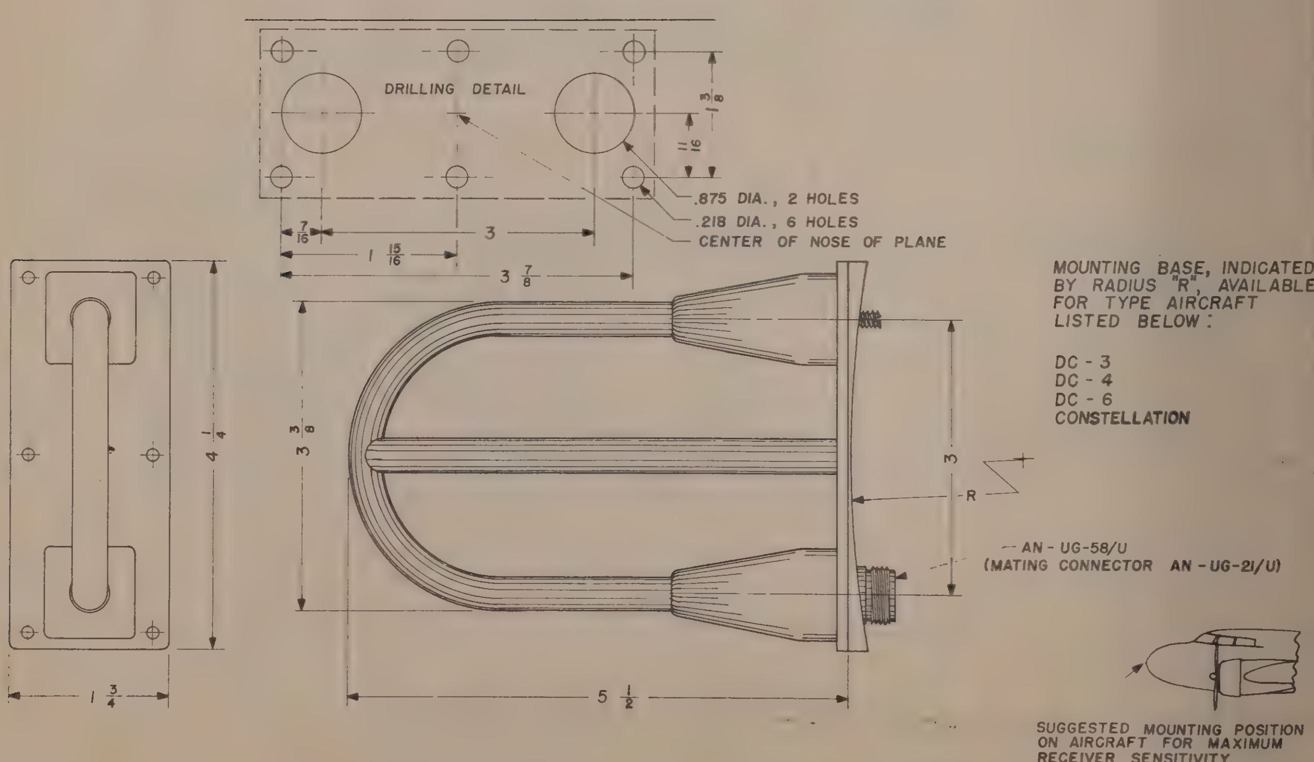
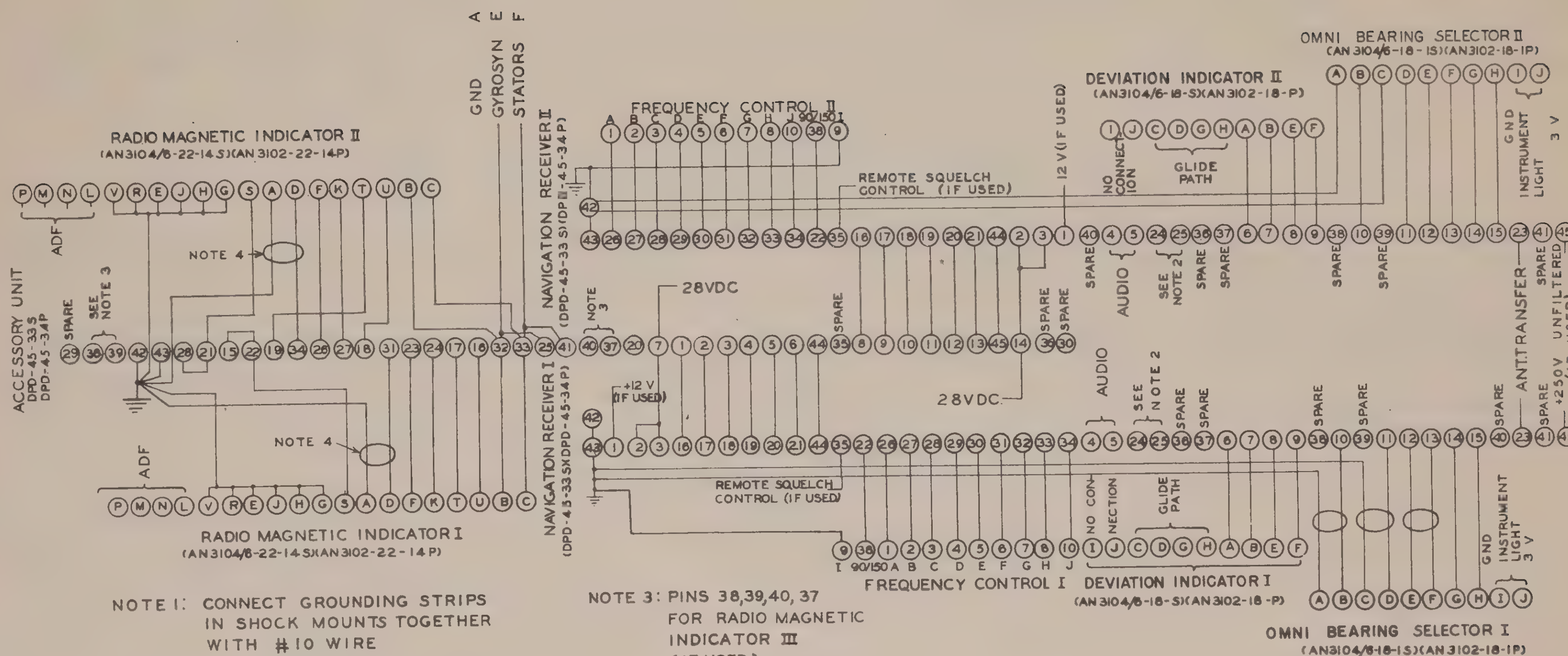


Figure 2-16 Type 37P-1 Glide Shape Antenna



NOTE 1: CONNECT GROUNDING STRIPS IN SHOCK MOUNTS TOGETHER WITH #10 WIRE

NOTE 2: PINS 24 & 25 ARE FOR 26V 400 ∿ THESE PINS NEED NOT BE WIRED WHEN USING COLLINS 51R RECEIVER PIN 24 GND IF 400∿ IS GROUNDED

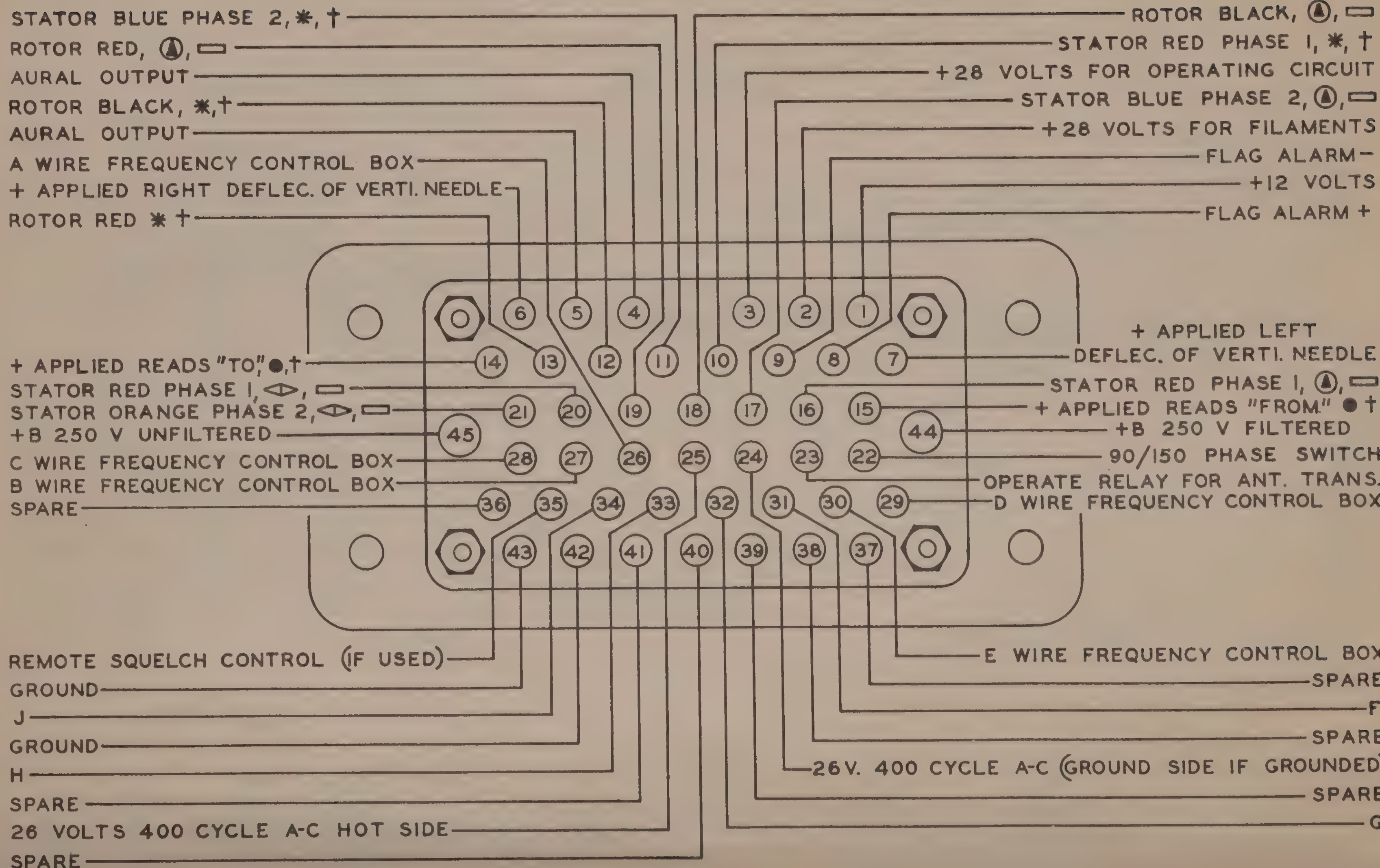
NOTE 3: PINS 38,39,40, 37 FOR RADIO MAGNETIC INDICATOR III (IF USED)

NOTE 4: PAIRS SHOWN LOOPED TOGETHER SHOULD BE SHIELDED TOGETHER OR INDIVIDUALLY

Figure 2-17 VHF Navigation System Wiring Details

(RECEIVER)

WIRED SIDE OF SHOCKMOUNT CONNECTOR



KEY TO SYMBOLS

✱ PHASE SHIFTER ● AMBIGUITY INDICATOR ▲ PHASE SHIFTER ◁▷ CONTROL MOTOR ▭ RADIAL INDICATOR

† RADIAL SELECTOR

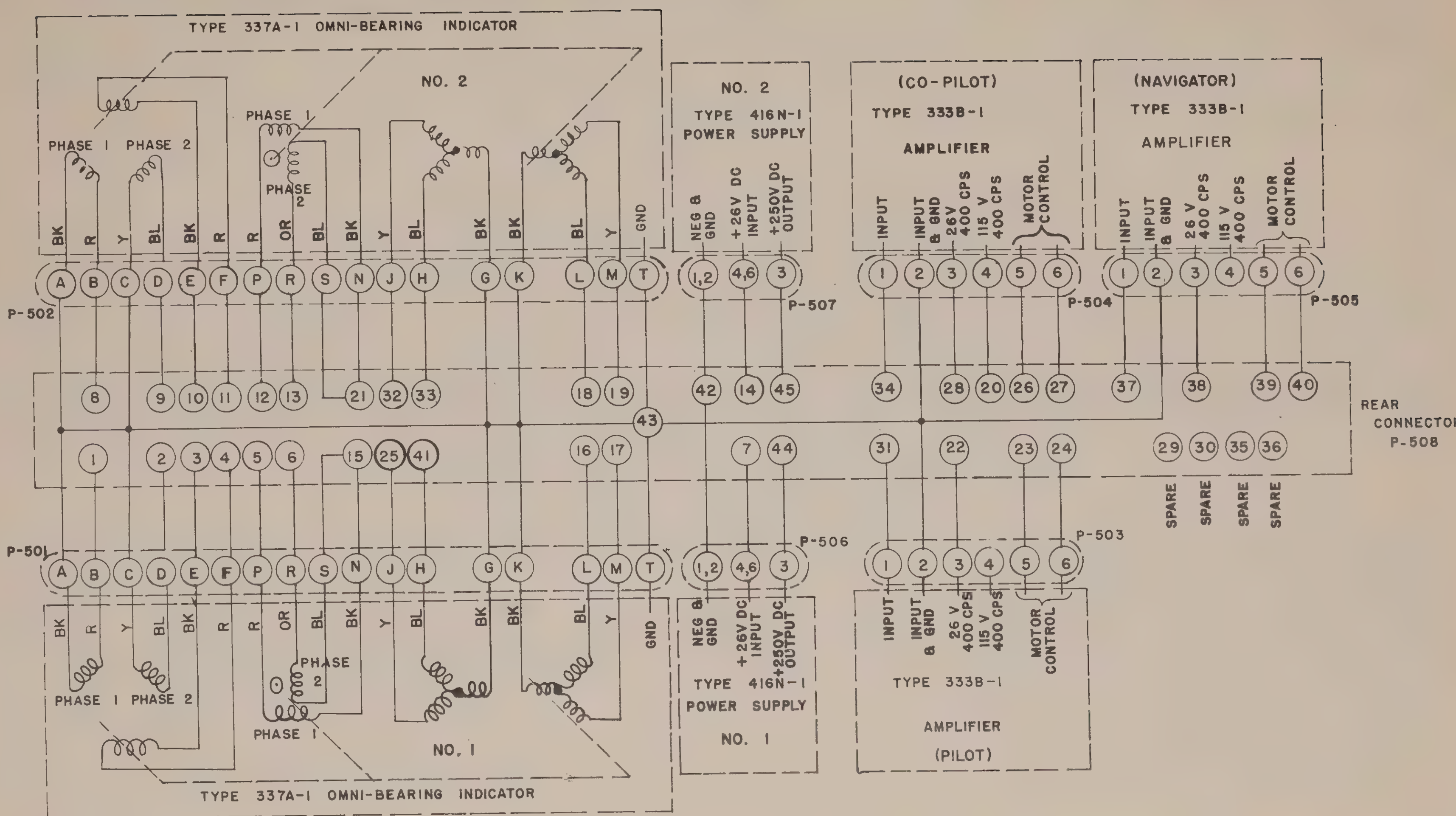
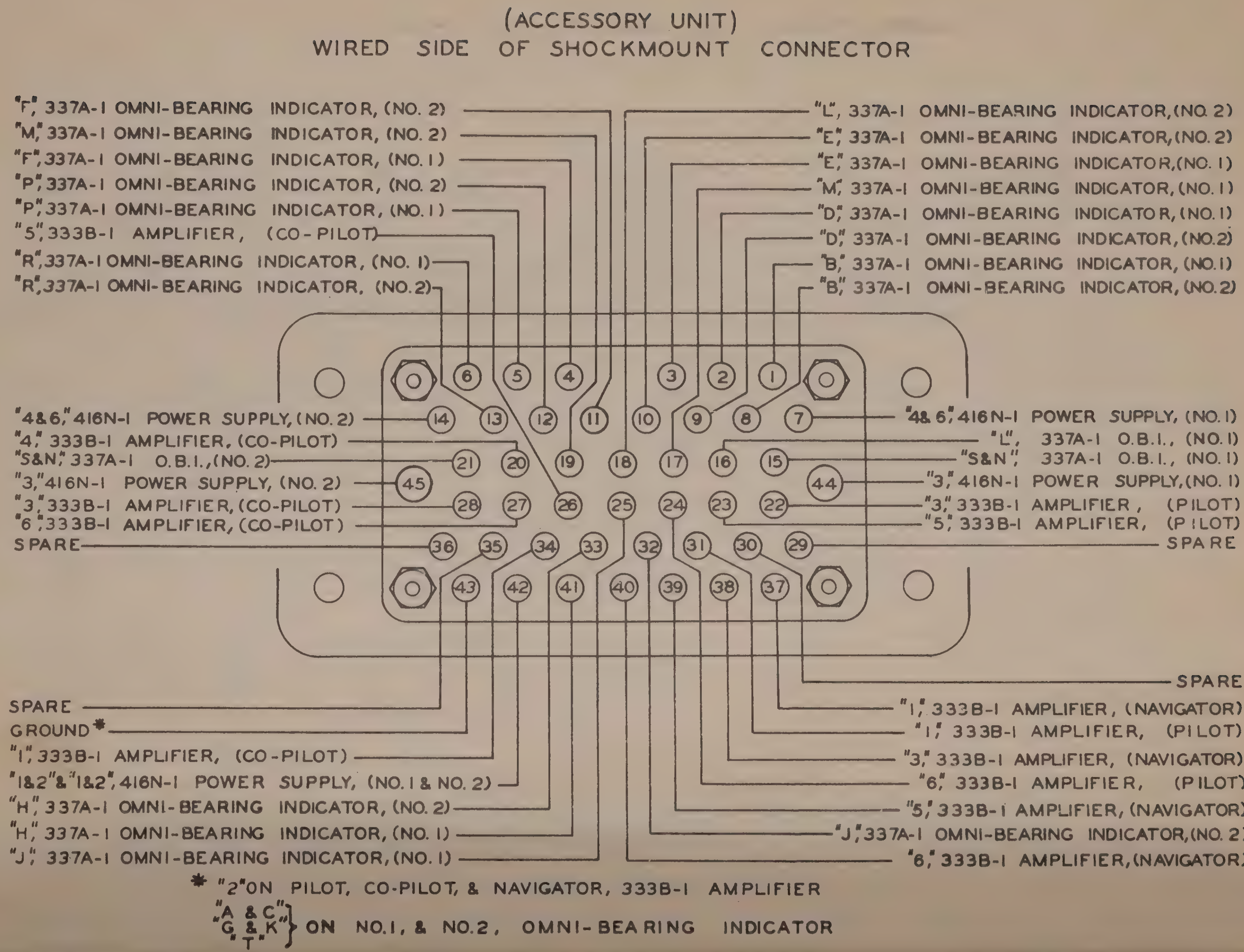


Figure 2-19 351A-1 Accessory Unit, Connection Diagram


(ACCESSORY UNIT)
WIRED SIDE OF SHOCKMOUNT CONNECTOR
"F", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"M", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"F", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"P", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"P", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"5", 333B-1 AMPLIFIER, (CO-PILOT)
"R", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"R", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"L", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"E", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"E", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"M", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"D", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"D", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"B", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"B", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
1
2
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45
"4&6," 416N-1 POWER SUPPLY, (NO. 2)
"4," 333B-1 AMPLIFIER, (CO-PILOT)
"S&N," 337A-1 O.B.I., (NO. 2)
"3," 416N-1 POWER SUPPLY, (NO. 2)
"3," 333B-1 AMPLIFIER, (CO-PILOT)
"6," 333B-1 AMPLIFIER, (CO-PILOT)
SPARE
"4& 6," 416N-1 POWER SUPPLY, (NO. 1)
"L", 337A-1 O.B.I., (NO. 1)
"S&N", 337A-1 O.B.I., (NO. 1)
"3," 416N-1 POWER SUPPLY, (NO. 1)
"3," 333B-1 AMPLIFIER, (PILOT)
"5," 333B-1 AMPLIFIER, (PILOT)
SPARE
SPARE
GROUND*
"1", 333B-1 AMPLIFIER, (CO-PILOT)
"1&2" & "1&2", 416N-1 POWER SUPPLY, (NO. 1 & NO. 2)
"H", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"H", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"J", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
SPARE
"1," 333B-1 AMPLIFIER, (NAVIGATOR)
"1," 333B-1 AMPLIFIER, (PILOT)
"3," 333B-1 AMPLIFIER, (NAVIGATOR)
"6," 333B-1 AMPLIFIER, (PILOT)
"5," 333B-1 AMPLIFIER, (NAVIGATOR)
"J," 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"6," 333B-1 AMPLIFIER, (NAVIGATOR)
* "2" ON PILOT, CO-PILOT, & NAVIGATOR, 333B-1 AMPLIFIER
"A & C" "G & K" "T" ON NO.1, & NO.2, OMNI-BEARING INDICATOR

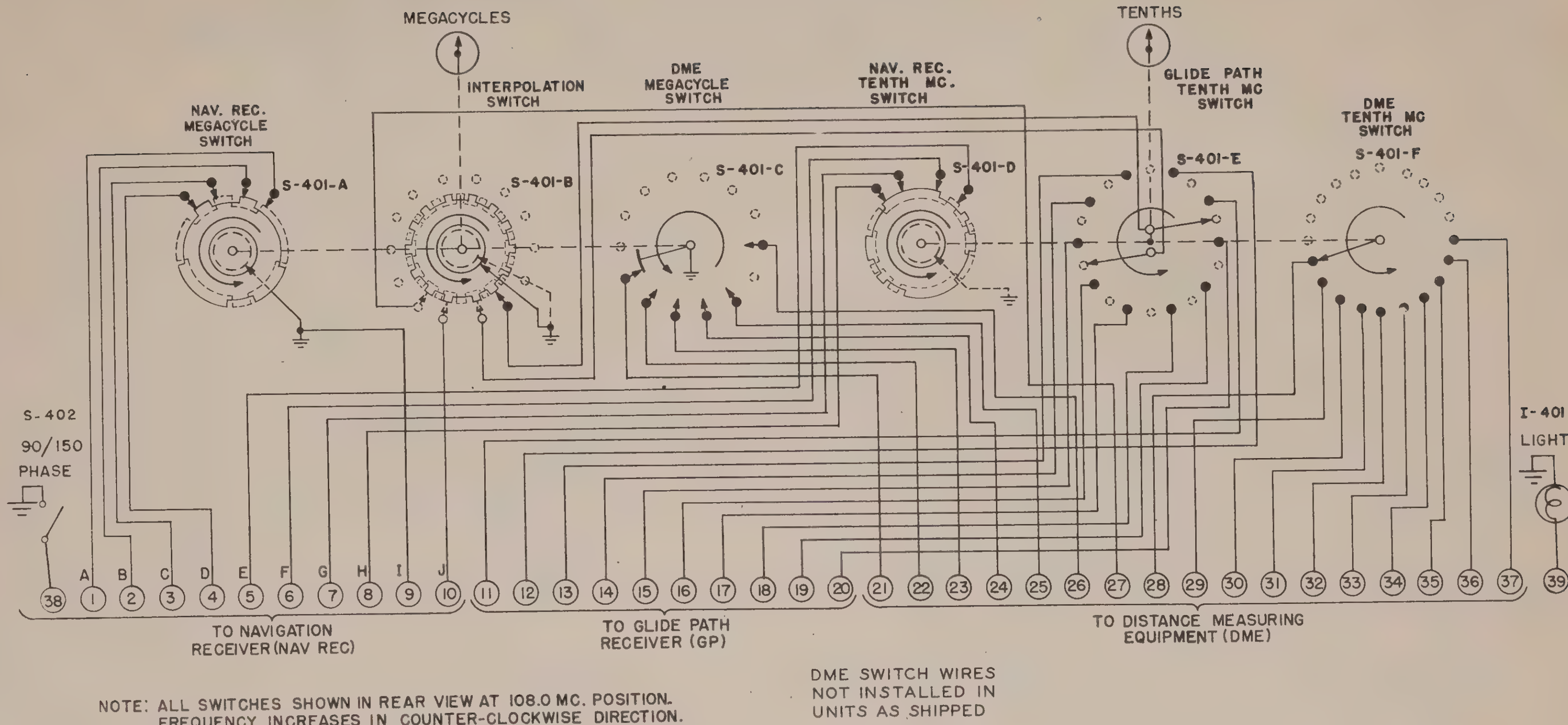


Figure 2-22 314U-1 Frequency Control Unit, Schematic Diagram

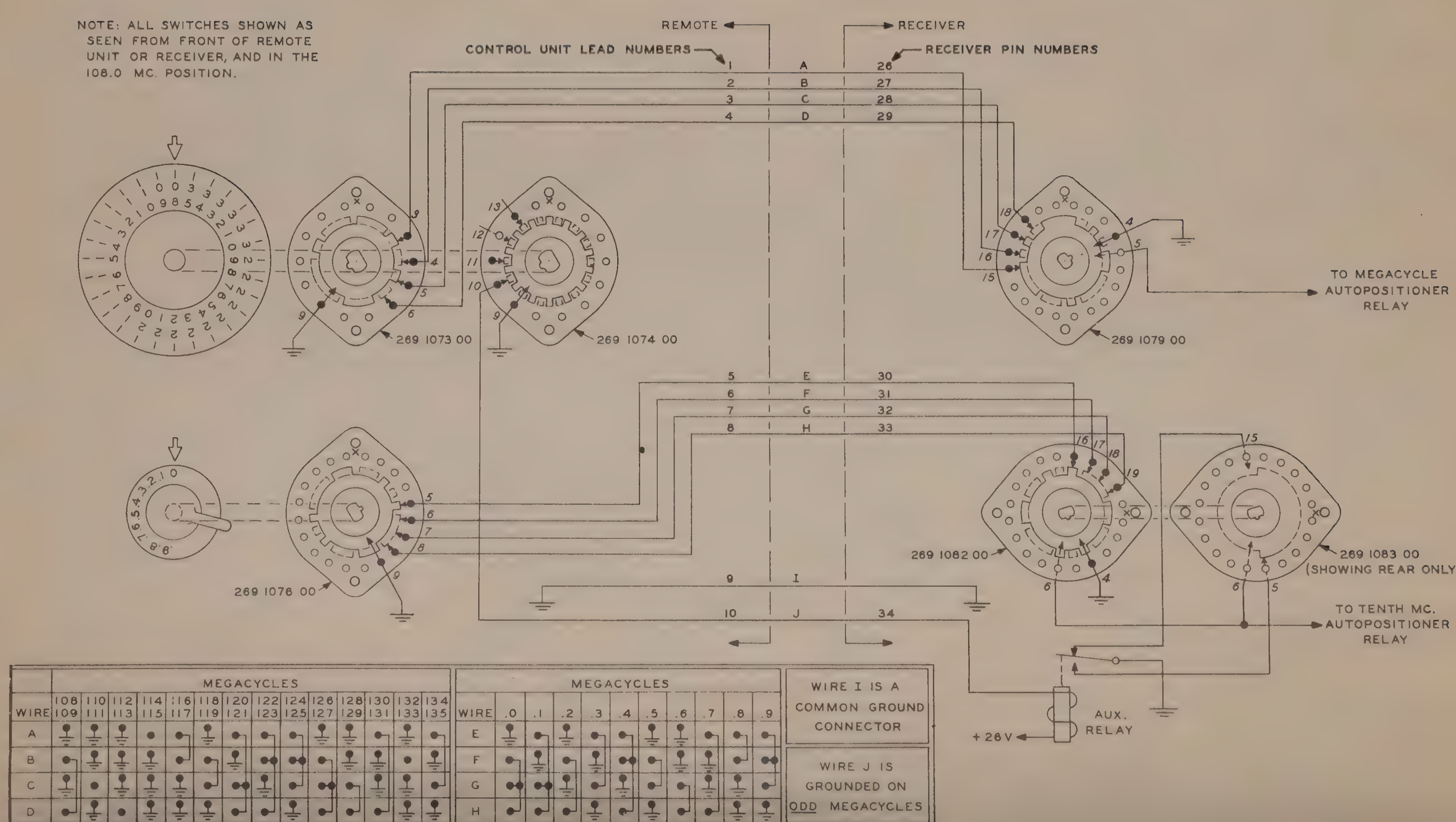


Figure 2-23 Schematic Remote Control System - 51R Receiver

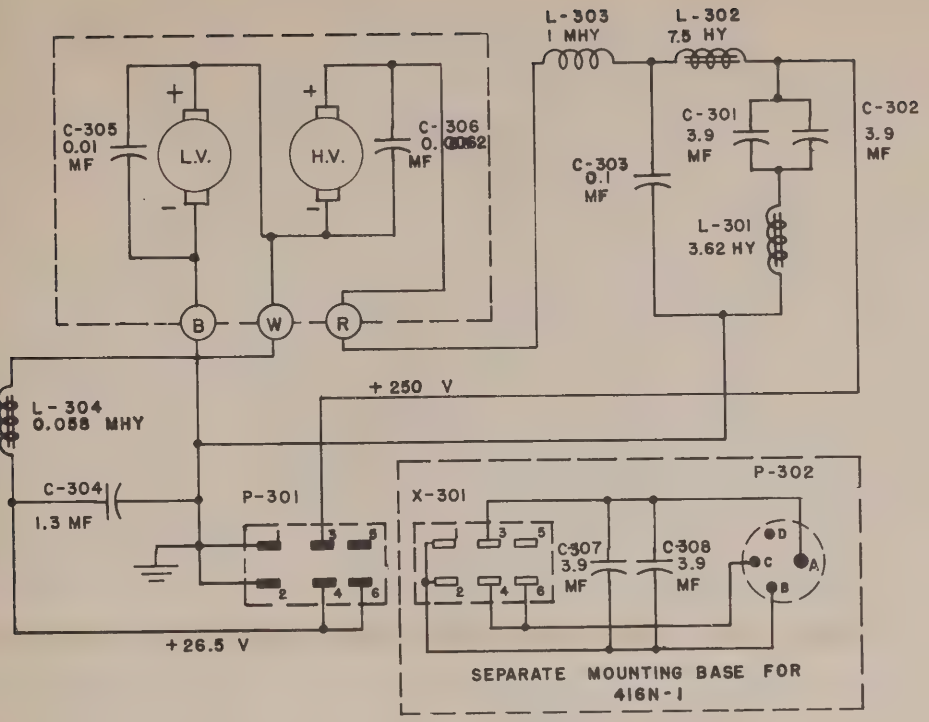


Figure 2-24 416N-1 Power Supply, Schematic Diagram

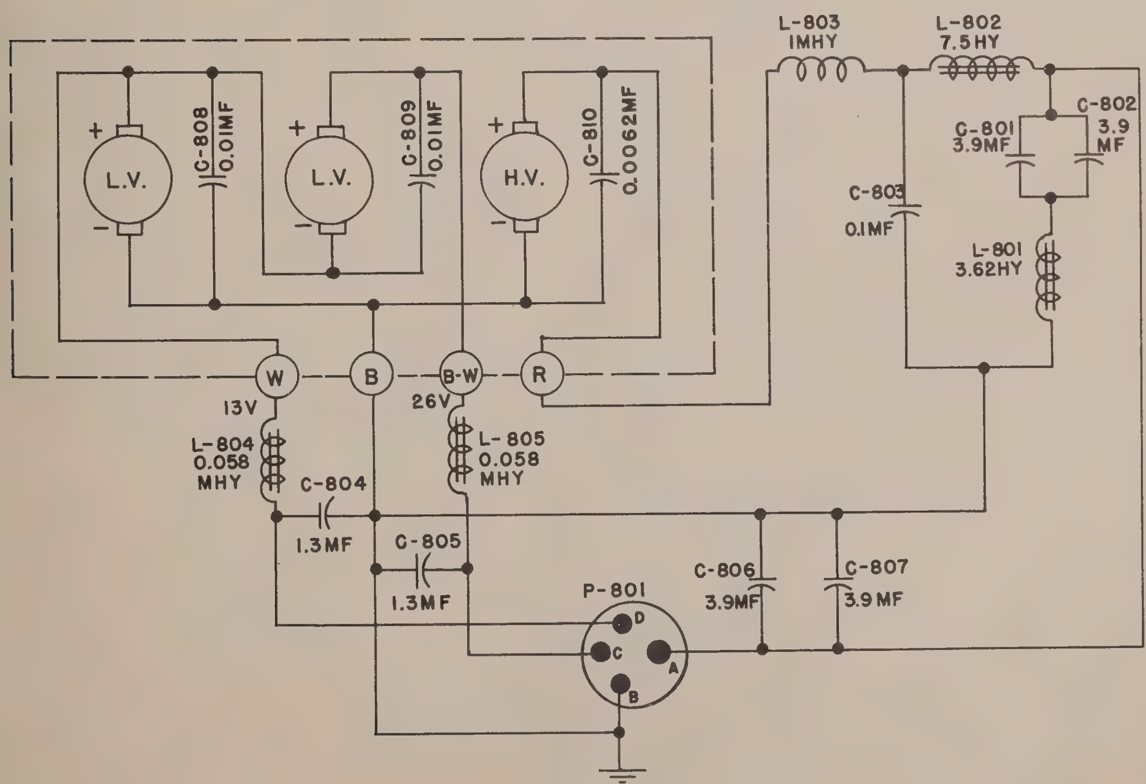


Figure 2-25 416N-2 Power Supply, Schematic Diagram

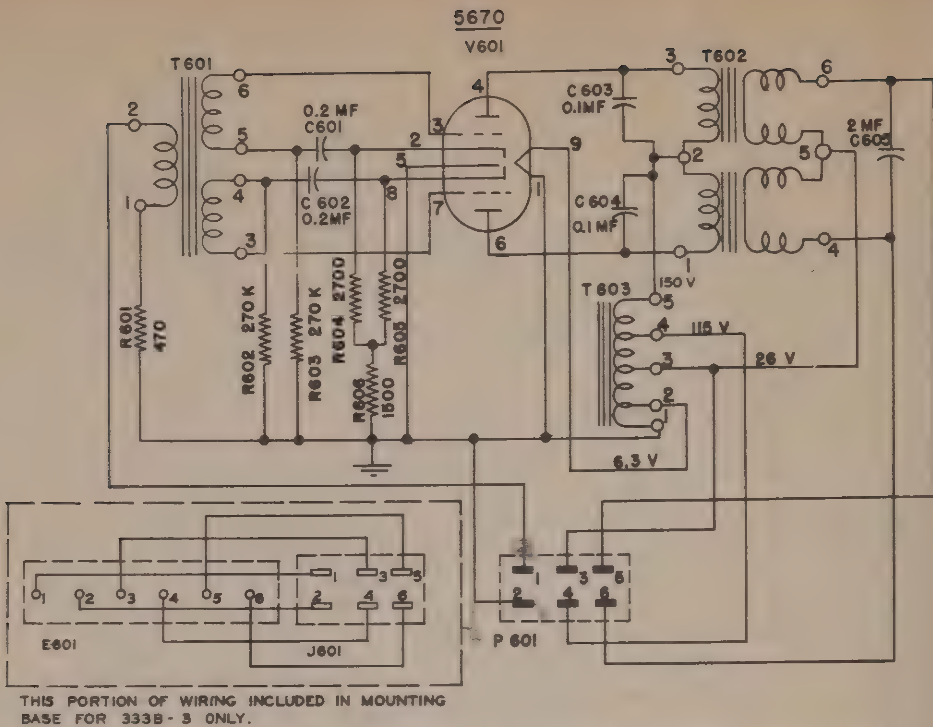


Figure 2-26 333B-1 and 333B-3 Servo Amplifier Schematic

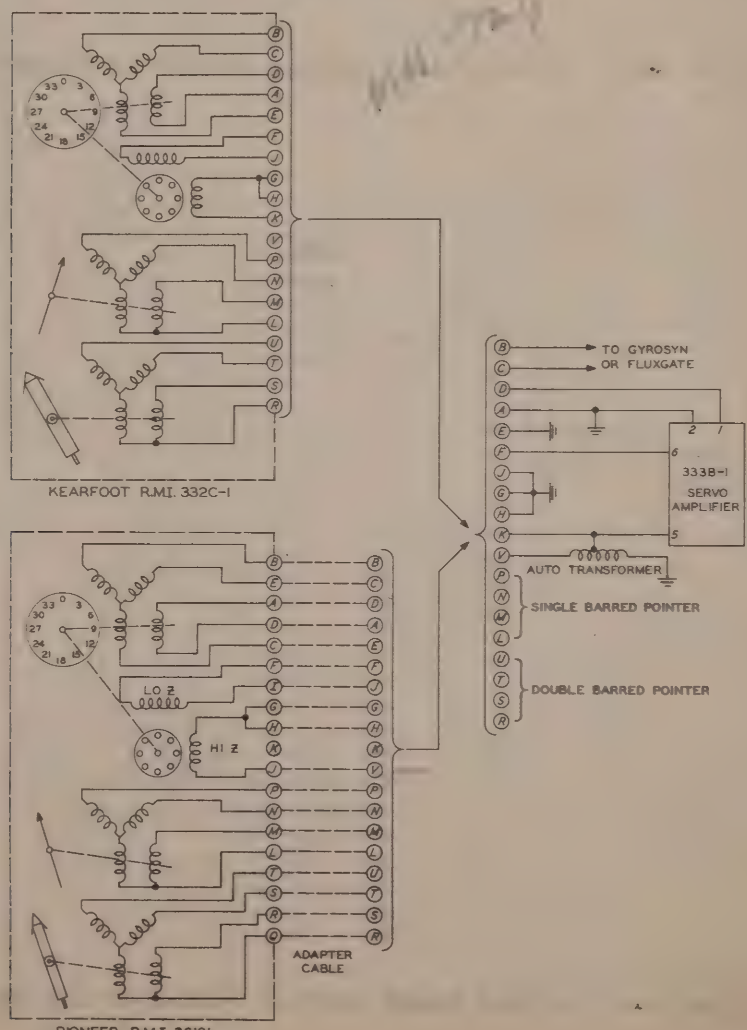


Figure 2-27 Kearfoot and Pioneer RMI Connections

SECTION 3

ADJUSTMENT AND OPERATION

The adjustment and operation of the Collins 51R Navigation Receiver and accessories is comparatively simple. There are no adjustments that need be performed after the equipment has been installed. A number of checks can be made to determine if the system is operating properly while the equipment is in the plane. These equipment checks will be outlined in the maintenance section of this instruction book. If these checks indicate that the equipment is not operating entirely satisfactorily, it will usually be necessary to remove the equipment from the plane and thus the adjustment becomes a maintenance problem. Detailed circuit alignment, voltage, resistance and phase angle measurements and trouble shooting procedures will be included in Section 5.

Operation of the equipment consists of selecting the frequency to be received with the frequency control unit and selecting the track with the omni-bearing selector. From there on the indicators tell the story.

SECTION 4

CIRCUIT DESCRIPTION

4.1, RECEIVER R-F AND AUDIO CIRCUITS.

4.1.1. R-F AND I-F AMPLIFIER CIRCUITS. - The Collins 51R Receiver utilizes a double conversion superheterodyne circuit. One stage of tuned r-f amplification is used. The grid and plate tank circuits of the r-f amplifier, V101, cover the frequency range 108.0 mc to 135.9 mc. The tuned circuits are designed to admit a 2 mc band of frequencies. The output of the r-f amplifier is coupled to the 1st mixer, V102. The excitation voltage for the 1st mixer is supplied by a two stage exciter consisting of a crystal controlled oscillator and a frequency multiplier. The tuning of the grid and plate circuits of the r-f amplifier, the crystal selector switch and the tuning of the crystal oscillator and frequency multiplier circuits is ganged. These ganged circuits are operated by the megacycle Autopositioner. The megacycle Autopositioner has 14 positions. Fourteen crystals are used in the high frequency oscillator circuit. The Autopositioner and the r-f circuit components have been selected so that the 14 positions cover the frequency range 108.0 to 135.9 mc. The positions or channels are 2 mc apart throughout this frequency range.

The crystals in the grid circuit of the high-frequency oscillator tube, V112, have been selected so that injection frequencies in the range 88.5 to 114.5 mc are obtained. These injection frequencies when mixed with the output of the r-f amplifier tube produce intermediate frequencies in the range 19.5 to 21.4 mc. The output of the 1st mixer is fed to the variable frequency i-f amplifier, V103. The tuning of the two i-f transformers, T103 and T104, is ganged with the low frequency injection oscillator crystal selector switch and the tuning of the output of the oscillator. Twenty crystals are available for use in the grid circuit of the low frequency oscillator, V113. The frequencies of these crystals are such that 20 injection frequencies in the range 16.3 to 18.2 mc are available for injection into the 2nd mixer. Eighteen of the twenty crystals operate at one-half output frequency and the other two operate at one-third output frequency (crystals #26 and 30). The i-f oscillator crystal selector switch, the tuning of the oscillator plate tank circuit and the tuning of the variable i-f amplifier stage are operated by the tenth megacycle Autopositioner. Referring to the received frequency, it is thus possible to select any one of 20 frequencies of the 2 mc band of frequencies that is passed by the r-f amplifier.

The Autopositioners are operated by the manual channel selector switch on the control unit and by the motor that is located on the front panel of the receiver. For each position of the megacycle positioner, 20 positions of the tenth megacycle positioner are available. The selecting of the desired channel selector automatically operates the Autopositioners to select the proper crystals for both oscillators and tunes the r-f amplifier and variable i-f amplifier stages to the desired frequency. The output of the i-f oscil-

lator is in the frequency range 16.3 to 18.2 mc. Twenty different frequencies in this range are available for injection into the second mixer. Because the crystal selecting and tuning circuits are ganged, the injection frequency that will result in a 3.2 mc i-f signal is always automatically selected.

The remote control unit, 314U, provides control for the 280 channels by use of 28 megacycle positions and 10 tenth megacycle positions. Because of design considerations, these 280 channels are obtained in a slightly different combination in the receiver itself. In the receiver the megacycle positioner controls 14 two megacycle positions and the tenth megacycle positioner controls 20 one-tenth megacycle positions. Thus the remote decimal system 28 x 10 is converted to a 14 x 20 system in the receiver. This is actually accomplished by use of the relay K103 (on the front panel of the receiver) in conjunction with auxiliary remote control switching shown in figure 2-23. The frequency to which the receiver is tuned may easily be determined by means of the dials (on the positioners) which are visible from the front of the receiver with the cover removed. Slots are provided on the positioner main plates through which these dials are visible. To obtain frequency, take the megacycle positioner (upper left) dial reading (108, 110, etc.) and to it add the tenth megacycle dial reading (0.0, 0.1, etc.). Example: Dial readings of 114 and 1.7 denote a frequency of 115.7 megacycles.

The positioners may be manually operated from the front panel of the receiver provided (1) the remote control unit is not connected and (2) 28 volt d-c power is applied to the receiver. A description of manual operation is found in the section entitled "Adjustment and Operation".

The above is in general a description of how the r-f section of the 51R Receiver works. To aid the reader in understanding the methods employed and results obtained, the following table and examples are included.

nnel Selec-r position		Received Frequency	Passed by R-F Circuits	1st Mixer Inj. Freq.	Variable I-F	2nd Mixer Inj. Freq.	Fixed I-F
c	.1 Mc						
mc	0.0	108.0 mc	108.0 to 110.0	88.5 mc	19.5 mc	16.3 mc	3.2 mc
	0.1	108.1	108.0 to 110.0	88.5	19.6	16.4	3.2
	0.2	108.2	108.0 to 110.0	88.5	19.7	16.5	3.2
	0.3	108.3	108.0 to 110.0	88.5	19.8	16.6	3.2
	0.4	108.4	108.0 to 110.0	88.5	19.9	16.7	3.2
	0.5	108.5	108.0 to 110.0	88.5	20.0	16.8	3.2
	0.6	108.6	108.0 to 110.0	88.5	20.1	16.9	3.2
	0.7	108.7	108.0 to 110.0	88.5	20.2	17.0	3.2
	0.8	108.8	108.0 to 110.0	88.5	20.3	17.1	3.2
	0.9	108.9	108.0 to 110.0	88.5	20.4	17.2	3.2
	1.0	109.0	108.0 to 110.0	88.5	20.5	17.3	3.2
	1.1	109.1	108.0 to 110.0	88.5	20.6	17.4	3.2
	1.2	109.2	108.0 to 110.0	88.5	20.7	17.5	3.2
	1.3	109.3	108.0 to 110.0	88.5	20.8	17.6	3.2
	1.4	109.4	108.0 to 110.0	88.5	20.9	17.7	3.2
	1.5	109.5	108.0 to 110.0	88.5	21.0	17.8	3.2
	1.6	109.6	108.0 to 110.0	88.5	21.1	17.9	3.2
	1.7	109.7	108.0 to 110.0	88.5	21.2	18.0	3.2
	1.8	109.8	108.0 to 110.0	88.5	21.3	18.1	3.2
	1.9	109.9	108.0 to 110.0	88.5	21.4	18.2	3.2
	0.0	110.0	110.0 to 112.0	90.5	19.5	16.3	3.2
	0.1	110.1	110.0 to 112.0	90.5	19.6	16.4	3.2

The preceding table shows how the double conversion system operates to obtain the 3.2 mc signal for application to the grid of the 1st fixed i-f amplifier tube, V105. The table could be completed to give the same information for received frequencies up to 136 mc. As will be noted in the table, the r-f circuits pass a 2 mc band of frequencies for each position of the megacycle Autopositioner. The tenth megacycle Autopositioner selects the desired frequency from the 20 frequencies that are available for each position of the megacycle Autopositioner. The frequency of the injection voltage for the 1st mixer changes with the operation of the megacycle Autopositioner, but is the same for the 20 positions of the tenth megacycle Autopositioner. The frequency of the variable i-f amplifier is varied in the range 19.5 to 21.4 mc for each position of the megacycle Autopositioner. That is, the variable i-f is different for each position of the tenth megacycle Autopositioner. The frequency of the 2nd mixer injection voltage is varied in the frequency range 16.3 to 18.2 mc for each position of the megacycle Autopositioner. As a result the fixed i-f is always 3.2 mc.

The fixed i-f system utilizes three stages of highly selective amplification. These three stages of fixed frequency i-f amplification, added to the selectivity obtained in the preceding tuned r-f and i-f amplifier stages, give a very high degree of image and adjacent channel rejection.

4.1.2. DETECTOR, AVC, AUDIO SQUELCH AND NOISE LIMITER. - A conventional diode detector is used to demodulate the signal output of the third fixed i-f stage. One section of dual triode V108 is used as the signal detector and the other section of the same tube is used as the AVC rectifier. Both triode sections of V108 are converted to diode detectors by connecting the grids to the plates.

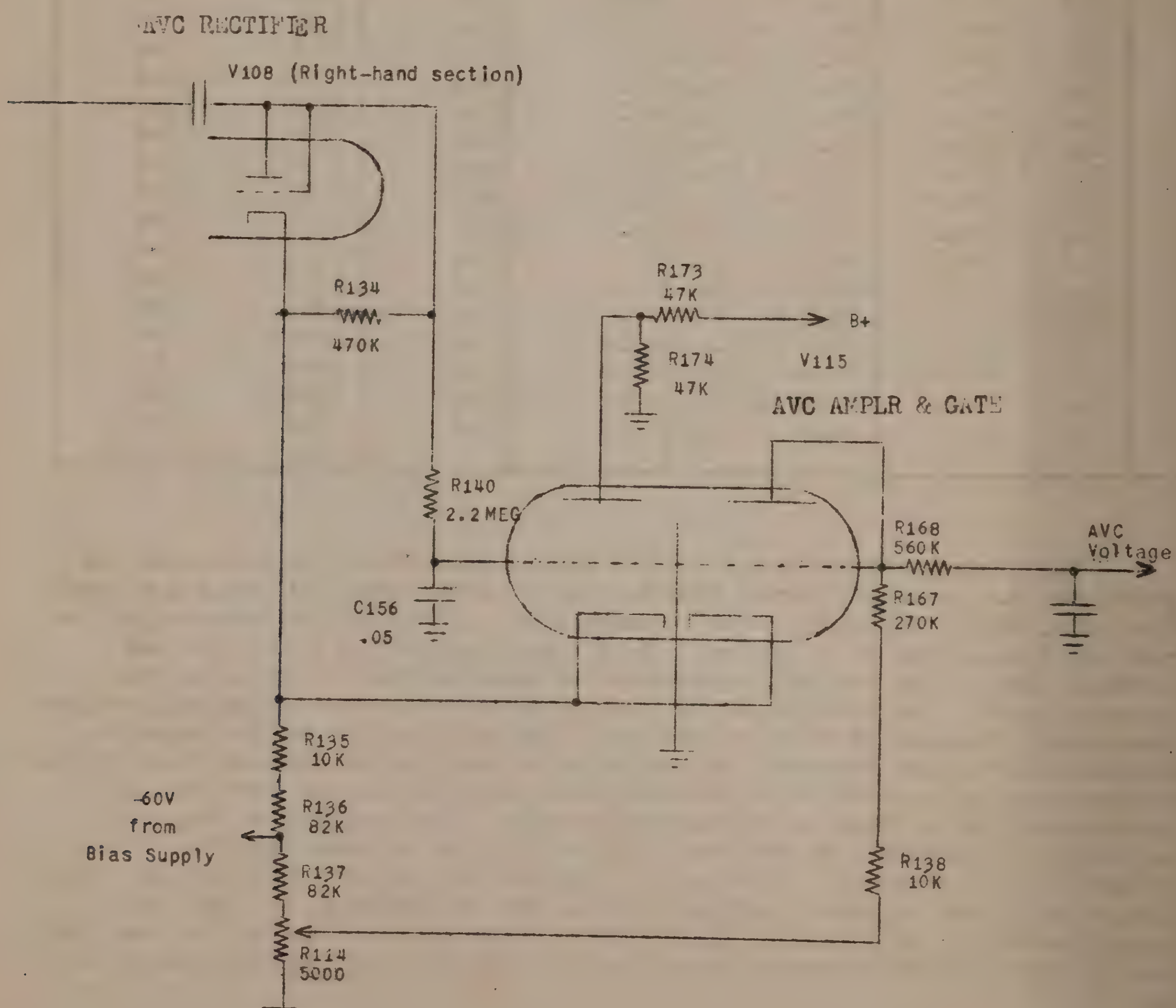


Figure 4-3 AVC Control Circuit

The AVC system used in the 51R Receiver maintains the output of the receiver substantially constant over a wide range of incoming signal levels. An amplified system of AVC is employed. The system consists basically of three parts: AVC detector, AVC amplifier and AVC gate. Referring to the 51R-1 Receiver schematic, the right-hand triode section of V108 is connected as a diode and is used as the AVC detector, the left-hand section of V115 is used as the AVC amplifier and the right-hand section of the same tube is used as the AVC gate. The amplifier is not a signal amplifier but is a d-c amplifier. Operation of the AVC circuit is as follows.

With no incoming signal, little or no voltage is developed across diode load resistor R134 and therefore as the circuit is traced from the grid of the AVC amplifier to the cathode of the same section of V115, it will be found that the grid and cathode are essentially at the same potential. Plate voltage for the AVC amplifier is obtained from the voltage divider consisting of resistors R173 and R174. Thus with a positive voltage applied to the plate and no bias on the grid, the tube will conduct. The current path is thru plate resistor R173 and voltage divider resistors R114, R137, R136 and R135.

Leaving the AVC amplifier for the moment, refer to the schematic again and consider tube V114 and its associated components. This tube and the circuit in which it is used provides the bias voltage necessary for the proper operation of the AVC and audio squelch circuits. One triode section of V114 operates as an oscillator and the remaining section, connected as a diode, rectifies the output of the oscillator section. The d-c voltage thus obtained is coupled to the voltage dividing network previously mentioned, at the junction of resistors R136 and R137.

Returning to the AVC system, the voltage developed across resistors R135, R136, R137 and R114 by the flow of current thru the amplifier section of V115 overcomes the fixed bias voltage and the cathodes of V115 are positive with respect to ground. As a result the AVC gate, the right-hand section of V115, is closed (no current flows) and no AVC voltage is developed across R167. The above conditions exist when no signal is being applied to the AVC detector.

Now consider the opposite condition, that is, assume that an incoming signal is being received. A portion of the output of the 3rd low i-f amplifier is applied to the AVC detector. The detector rectifies the signal and a voltage is developed across resistor R134. The voltage thus developed is applied as bias to the grid of the AVC amplifier. With the amplifier current reduced or possibly nearly cut off, little voltage is developed across the network (R135, R136, R137 and R114) and the cathodes of V115 become negative with respect to ground because of the bias applied to the junction of resistors R136 and R137. With this negative voltage applied to the cathode of the gate section of V115, current will flow thru the right-hand section of V115 and a voltage will be developed across resistors R167 and R138. The AVC voltage thus developed is applied to the control grids of four of the r-f and i-f amplifier tubes.

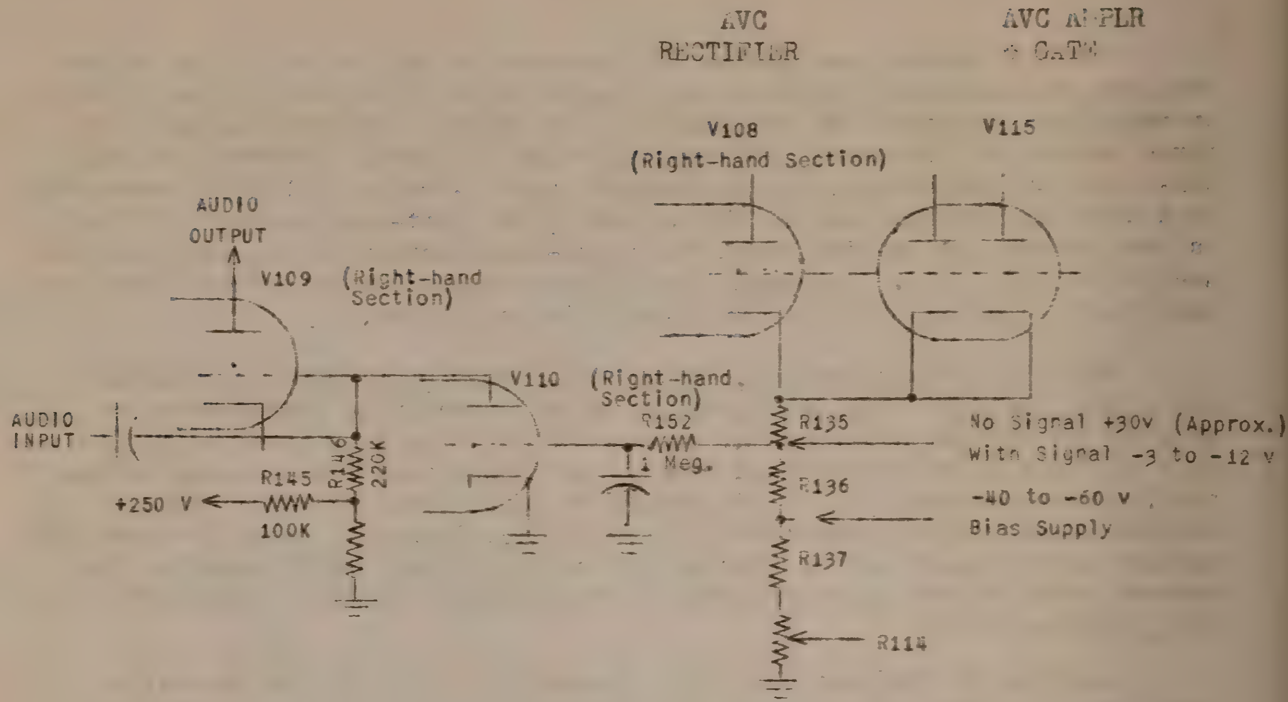


Figure 4-4 Audio Squelch Circuit

The audio squelch system utilizes the right-hand section of V110 and the bias voltage developed by V114. The operation of the circuit is as follows. Essentially the desired condition is that the 1st audio amplifier stage, the right-hand section of V109, is biased to cut-off when no signal is being received and the bias is removed when a signal is applied. The right-hand section of V110 develops this cut-off bias. The grid of V110 is connected to the junction of resistors R135 and R136 and therefore utilizes the fixed bias developed by V114 and the voltage developed by the AVC detector. As described above for the AVC circuit, with no signal being received, the upper end of the network of resistors becomes positive due to the flow of current thru the AVC amplifier. This positive voltage is applied to the grid of V110. The plate of V110 is connected to the high voltage supply thru resistors R146 and R145 so that when a positive voltage is applied to the grid, current flows thru the tube. This current flow develops a negative voltage across R146 which is applied to the grid of V109. Thus when no signal is being received, the 1st audio amplifier, right-hand section of V109, is biased to cut-off and the receiver is silent. When a signal is received, conditions are as described for the AVC circuit. That is, a comparatively large negative voltage exists at the junction of resistors R135 and R136, and the right-hand section of V110 is biased to cut-off. With the bias voltage applied to the grid of V110, current flow thru the tube is stopped and consequently the voltage developed across R146 ceases to exist. With no bias

voltage applied to the grid of the audio amplifier section of V109, the circuit functions normally and the audio signal appears in the output circuit of the receiver.

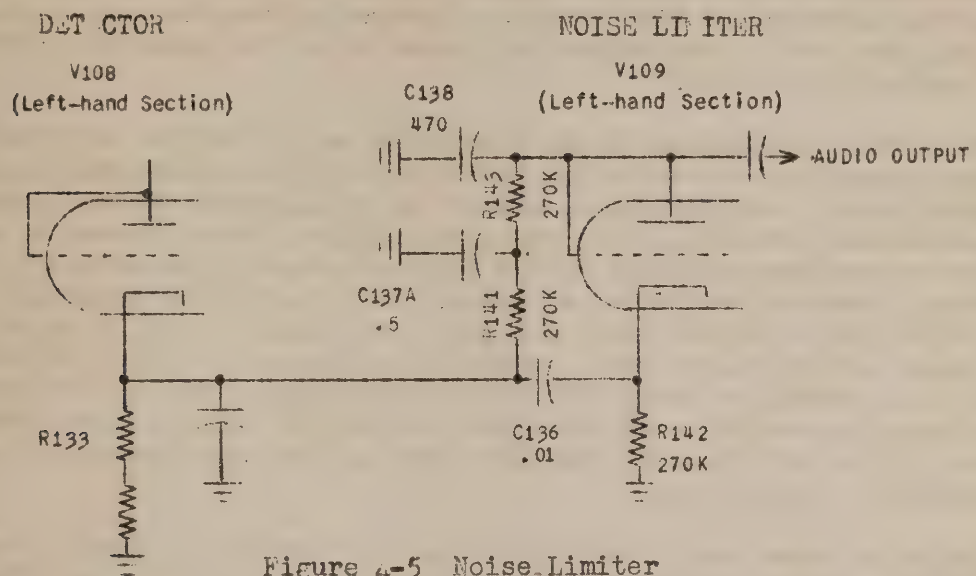


Figure 4-5 Noise Limiter

The noise limiter in the 51R Receiver utilizes the left-hand section of V109 in a peak-clipping, series type, limiter circuit. In operation, the pulsing positive voltage developed at the junction of the detector load resistor, R133, and the cathode of V108 is impressed upon the plate of the limiter section of V109. This voltage varies with the amplitude of the signal. The cathode of the limiter tube is coupled through capacitor C136 to this varying positive potential point and the plate is coupled to the same point through the filter section consisting of R141, C137A, R143 and C138. As a result of the positive d-c potential applied to the limiter plate, current flows thru the limiter tube. This current varies at an audio rate as a result of the voltage developed in the detector circuit. The voltage developed across resistor R143 as a result of the current flow thru the limiter is applied to the grid of the first audio amplifier stage. A sharp noise pulse, having an amplitude greater than the desired signal, and after rectification, being in the form of a sharp d-c pulse is coupled by capacitor C136 to the cathode of V109. This pulse causes the positive voltage on the cathode of V109 to become equal to or greater than the voltage that is applied to the plate. Therefore, for the instant, current flow thru the limiter section of V109 is interrupted and the noise above a certain percentage of modulation is not allowed to appear in the grid circuit of the first audio amplifier stage. As the noise peaks are usually of short duration and the recovery time of the limiter is practically instantaneous, the interruption of the signal is not noticeable.

4.2 INDICATING SYSTEM.

The 51R Receiver includes facilities for operation of the omnidirectional range and localizer indicating system. The radial converter indicator, which combines the magnetic and omnidirectional course information, is a separate instrument unit, but is controlled by a servo amplifier which is an integral part of the radio receiver.

Voltage from the detector feeds through an amplifier into a 10 kc filter, and thence through an additional amplifier to an FM discriminator where the omnidirectional range reference phase modulation frequency is removed from the 10 kc subcarrier. The modulation frequency is then passed through a phase splitting network and amplifier to the two quadrature field coils of a resolver which forms a part of the radial selector. Voltage from the resolver passes through an amplifier to the phase detector, and thence to the vertical needle of the cross pointer instrument. Immediately ahead of the 10 kc filter, the variable phase signal is taken off and passed through a 30 cycle filter, and thence through an amplifier to the phase detector feeding the cross pointer indicator. This portion of the circuit provides for cross pointer flying of any preselected radial track.

In order to insure safe and reliable use of the cross pointer track indicator, two auxiliary indicators are provided. These are (1) the flag alarm indicator on the face of the cross pointer meter, which obscures a portion of the needle when signal falls below a safe value, and (2) a TO-FROM meter which comprises a zero center up-down meter which reads in the "TO" sector when the aircraft is on a course reading toward the station, indicates in a "FROM" sector when the aircraft is on a course reading away from the station, and moves to a center section when either the reference or variable signals fall below a safe level.

The flag alarm indicator is operated from a rectified voltage taken from the phase detector signals. The ambiguity indicator is operated from a phase detector which is combined with the phase detector operating the course needle on the cross pointer indicator. In order to properly control the TO-FROM indicator, it is necessary to shift the phase of the variable voltage entering this second phase detector through an angle of 90 degrees. This means that the indicator will show the pilot which side of the station he is on, and will swing from a "TO" correct reading to a "FROM" incorrect reading if the aircraft crosses a course line 90 degrees displaced from the selected course. This has the effect of dividing the area around the station into four general areas.

For operation of the radio magnetic indicator on an automatic basis, a second resolver is connected in parallel with the resolver in the radial selector indicator, and this second resolver is automatically brought to a phase balance by a servo motor.

Provision for flying 90/150 cycle modulated localizers is made through the usual rectifier-filter arrangement. The flag alarm indicator of the cross pointer meter is controlled in a conventional way through the use of the common current flowing in the rectifier circuit.

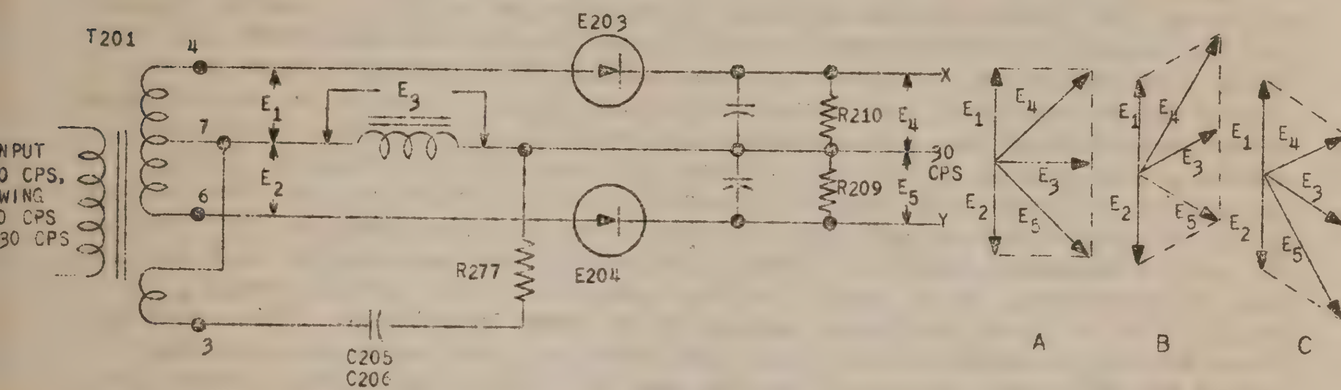


Figure 4-6 Frequency Discriminator Circuit

Operation of the cross pointer indicator on phase modulated localizers is provided for through the use of the phase detector which forms a part of the omnidirectional range indicator circuit. When flying phase type localizers, the reference input to the phase detector is switched so as to bypass the resolver in the manual course setting instrument.

4.3. DETAILED CIRCUIT DESCRIPTION.

4.3.1. INSTRUMENTATION CIRCUITS. - Referring to 51R-1 Receiver schematic (in envelope in rear of book), the operation of the instrumentation circuits will now be explained.

The last stage of the 3.2 mc i-f system feeds through T108 to V108, one-half of which is used as a diode detector. This tube is converted into a rectifier by connecting the plate to the grid. Resistors R132 and R133 comprise the diode load. A lead is taken off terminal 4 of T108, and thence to the audio system through terminal 10 on terminal board E101. This wire carries the signal through C201 to grid 3 of V201. Capacitor C201 has a value of 220 mmf and this in combination with R201 provides a high pass filter, thus presenting the grid of V201 with a signal essentially free of all low frequencies. The signal desired at this point is the 10 kc subcarrier upon which is impressed the reference omni-range signal by frequency modulation. Plate 4 of V201 couples through R203 and capacitor C203 to grid 7 of the same tube. Bias rectifiers E201 and E202 connect between grid 7 and ground and form a shunt limiter which clips the FM signal at a

level which puts approximately 50 volts across terminals 1 and 2 of T201, connected to plate 6 of V201. The 10 kc signal passes through T201 to the secondary windings which are connected with rectifiers E203 and E204, so as to form a frequency discriminator or frequency modulation detector.

The operation of the discriminator may be understood by reference to sketch of the discriminator circuit. Secondary 4-6 of T201 is center tapped and fed through selenium rectifiers E203 and E204 to load resistors R209 and R210. The center tap of these two load resistors is connected back to the center tap of secondary 4-6 through a reactor which is potted in the discriminator transformer can. This reactor is fed with voltage from a tertiary winding, terminal 3, through capacitors C205 and C206 and resistor R277. Capacitors C205 and C206 tune the reactor to series resonance at 9960 cycles. As the FM signal swings ±480 cycles from its center frequency of 9960 cycles, the series resonant circuit becomes alternately mistuned on the high and low side of resonance. As a result of the detuning of the series circuit, the phase of the voltage developed across the reactor is shifted. This shifting phase voltage is added to the equal and constant phase voltages appearing across the two equal halves of winding 4-6 to produce sum voltages which are applied through the rectifiers to the balanced output load resistors. The rectified voltages developed across the two opposed output resistors R209 and R210 vary cyclically as the center leg reactor voltage is shifted in phase through change in frequency and as a result of this process, the demodulated 30 cycle signal appears across points X and Y of the diagram.

Vector diagrams A, B, and C, illustrate the operation of the phase detector circuit. Referring to diagram A, it will be seen that the transformer secondary voltage E1, adds to the reactor center leg voltage E3 to produce a resultant E4 which is passed through rectifier E203 and appears as rectified output across R210. In a similar way the other half of the secondary voltage E2 adds to the center leg reactor voltage E3 and produces voltage E5, passing through rectifier E204 to appear across R209. The voltages across R209 and R210 are opposed to each other, and when the subcarrier signal is at its center frequency of 9960 cycles, the vector diagram of figure A applies, with a resultant zero output appearing across terminals X and Y of the discriminator. At a later time in the 30 cps modulating cycle the subcarrier frequency has risen to a frequency higher than 9960 with resultant detuning of the center leg reactor resonant circuit. Vector diagram B nowapplies. Here it will be seen that secondary voltage E1 adds to center leg reactor voltage E3 to produce the relatively long vector E4 which is rectified and appears across R210. At the same time secondary voltage E2 adds to center leg voltage E3 to produce a relatively short vector E5 which is rectified and appears across R209. It is apparent that E4 is considerably greater than E5 and consequently a net positive voltage appears across terminals X and Y at this instant in the modulating cycle. In a similar way at still another part of the modulating cycle, vector diagram C applies, resulting in production of the opposite polarity across terminals X and Y. The repetition of these vector conditions at

all points throughout the 30 cps modulating cycle results in the production of continuous 30 cycle output across terminals X and Y of the discriminator.

The 30 cycle signal developed by the FM discriminator passes through blocking condensers C209 and C210 and resistors R212 and R242 where it is applied to a phase splitting network. This network is connected so as to apply four 30 cycle voltages, separated in phase by 90 degrees, to the grids of V202 and V203. Tubes V202 and V203 are connected as cathode followers to feed exciting current to the phase shifters or resolvers contained in the pilot's omni-bearing selector, and the omni-bearing indicator. The operation of this circuit may be understood by reference to the sketch of the phase splitting network on page 4-6. The 30 cycle output from the FM discriminator feeds from terminals X and Y and is applied across resistors R211 and R215 and condensers C211 and C213. The resistors divide

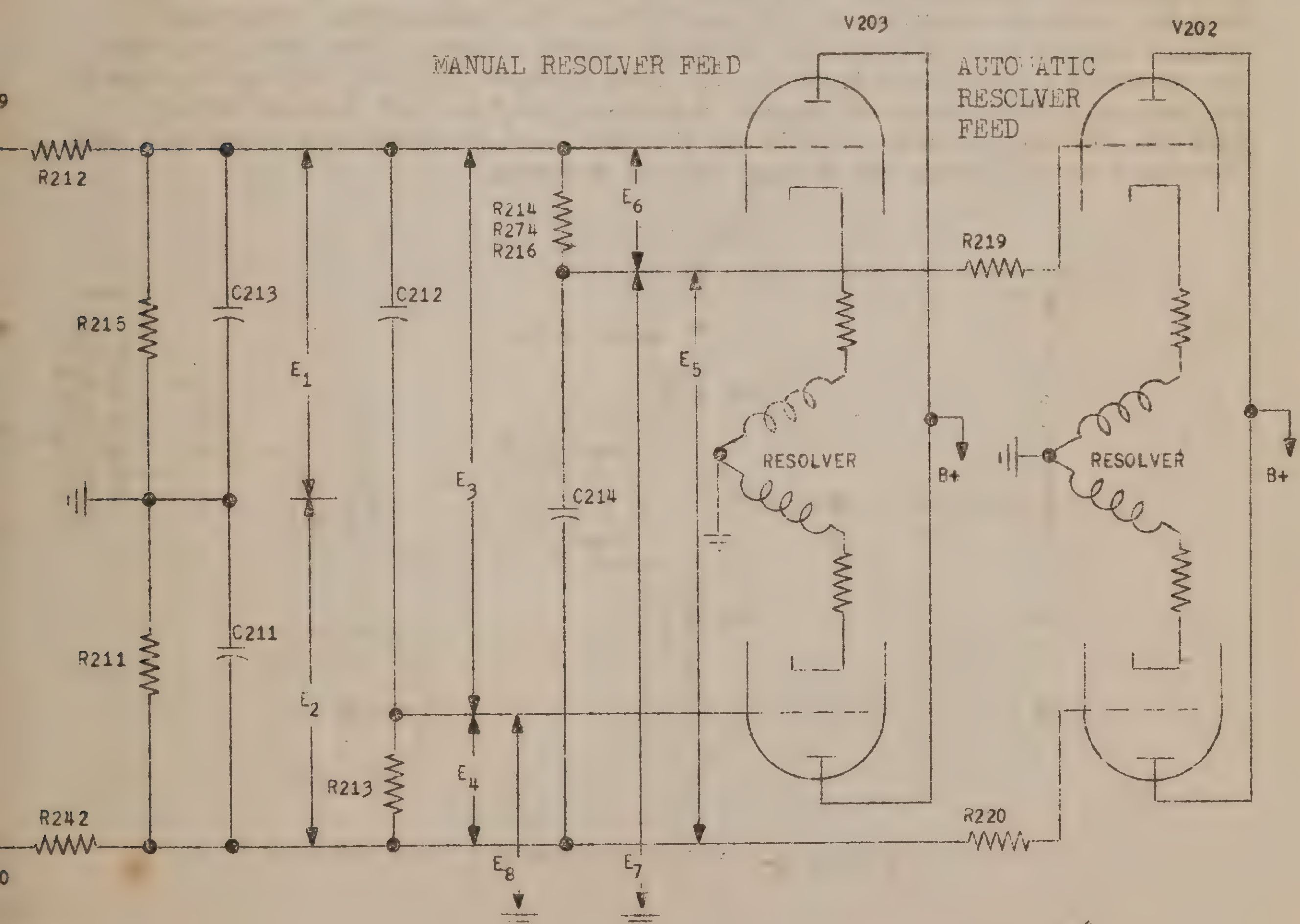
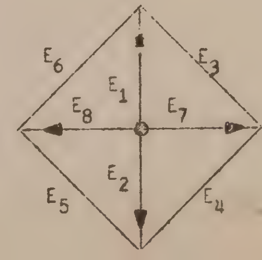


Figure 4-7 Resolver Exciter Circuit



the voltage into two equal halves, and the condensers serve as additional filtering for unwanted 9960 cycle carrier. The condenser and resistor network comprising R213 and C212 and 214 and 214 split the 30 cycle signal up into four equal vectors spaced at 90 degree intervals. These voltages are applied in proper sequence to the grids of V202 and V203. Cathode currents from these tubes flow through resistors R225, R226, R221 and R222 to the stator windings of the bearing selector and bearing indicator resolvers.

Vector diagram A of the sketch showing the phase splitting network shows the distribution of voltages around the network. The final resultant voltages applied to the grids of V202 and V203 are E1, E7, E2 and E8. It will be seen that E1 is applied to grid 3 of V203 while grid 7 of this same tube receives vector E8, which is 90 degrees displaced from E1. Similarly, grid 3 of V202 is supplied with vector E7, and grid 7 of this same tube with vector E2. As will be explained later, the phase shifting resolvers require a supply of quadrature currents to their stator coils. These currents are supplied from the cathode circuits of V202 and V203. The four-vector arrangement is used in order to balance out 30 cycle currents drawn from the plate supply by tubes V202 and V203. With all four vectors, E1, E2, E7 and E8, equal and properly disposed in 90 degree relationships, the net current drawn from the h-v supply will contain no 30 cycle a-c component and hence the difficulties of filtering and decoupling are reduced.

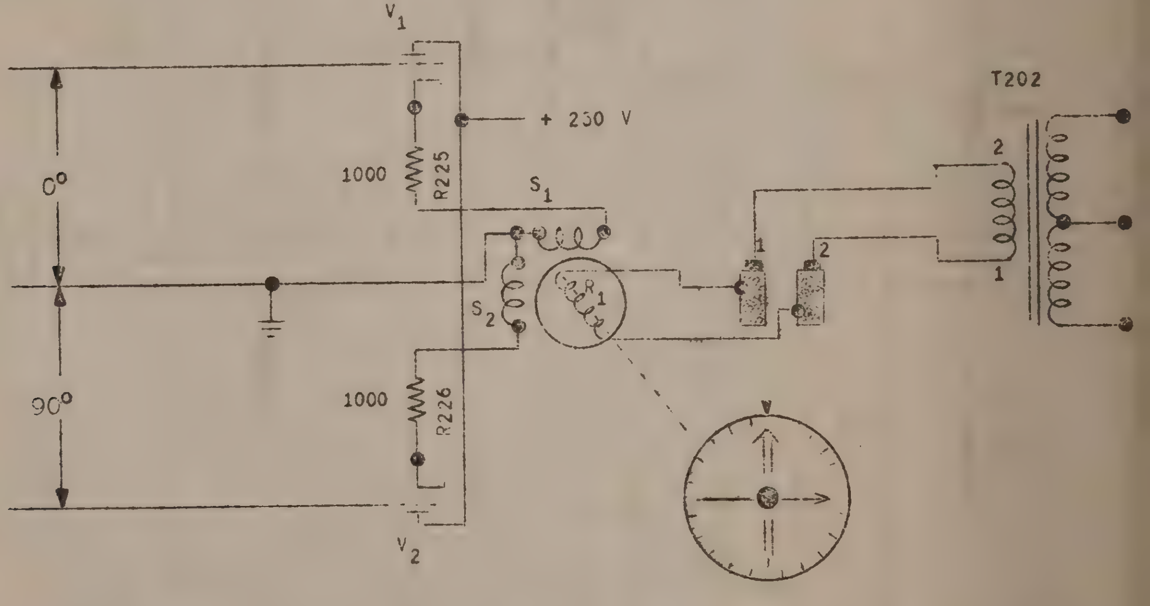
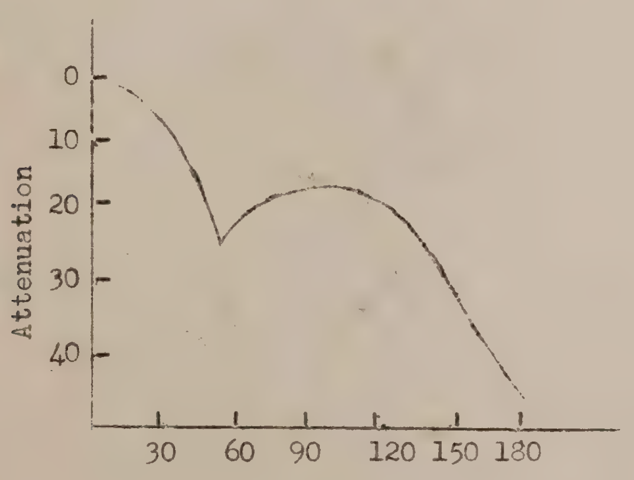


Figure 4-8 Typical Resolver Feed Circuit

Refer to the accompanying sketch of a simplified form of the resolver feed circuit as applied to a single resolver. The grid of V1 is fed with a 30 cycle signal and simultaneously the grid of V2 is fed with a similar signal displaced 90 degrees in phase. The stator coils S1, S2 of the resolver or phase shifter are connected in series with the cathode of V1 and V2 through a resistor of approximately 1000 ohms, R225 and R226. The combination of large series resistance plus the cathode follower connection results in a constant current feed to stators S1, S2. For like number of turns in these two stator windings, identical numbers of ampere turns are produced, thus resulting in equal a-c fields from the two stators in the resolver. Stators S1 and S2 are wound at 90 degrees to one another and as a result of their space quadrature and the phase quadrature of their supply currents, they produce a uniform resolver field surrounding the rotor R1 of the resolver. The action of the resolver is such as to cause the voltage across terminals 1 and 2 of the resolver to shift in phase one electrical degree for each mechanical degree through which the resolver rotor is turned. The voltage taken from the resolver rotor is fed to primary terminals 1 and 2 of input transformer T202, in the case of the cross pointer circuit, and from a similar resolver to terminals 1 and 2 of transformer T203 for operation of the automatic resolver in the omni-bearing indicator. The 1000 ohm resistors, R225 and R226 in series with resolver stators S1 and S2 serve as "swamping" resistors which tend to mask changes in resistance in the resolver stators which might result in azimuth errors as a function of temperature. These resistors, in combination with the cathode follower connection of tube sections V1 and V2, appears as a constant current feed to the resolver stators.



Frequency in CPS

30 Cycle Filter Characteristic

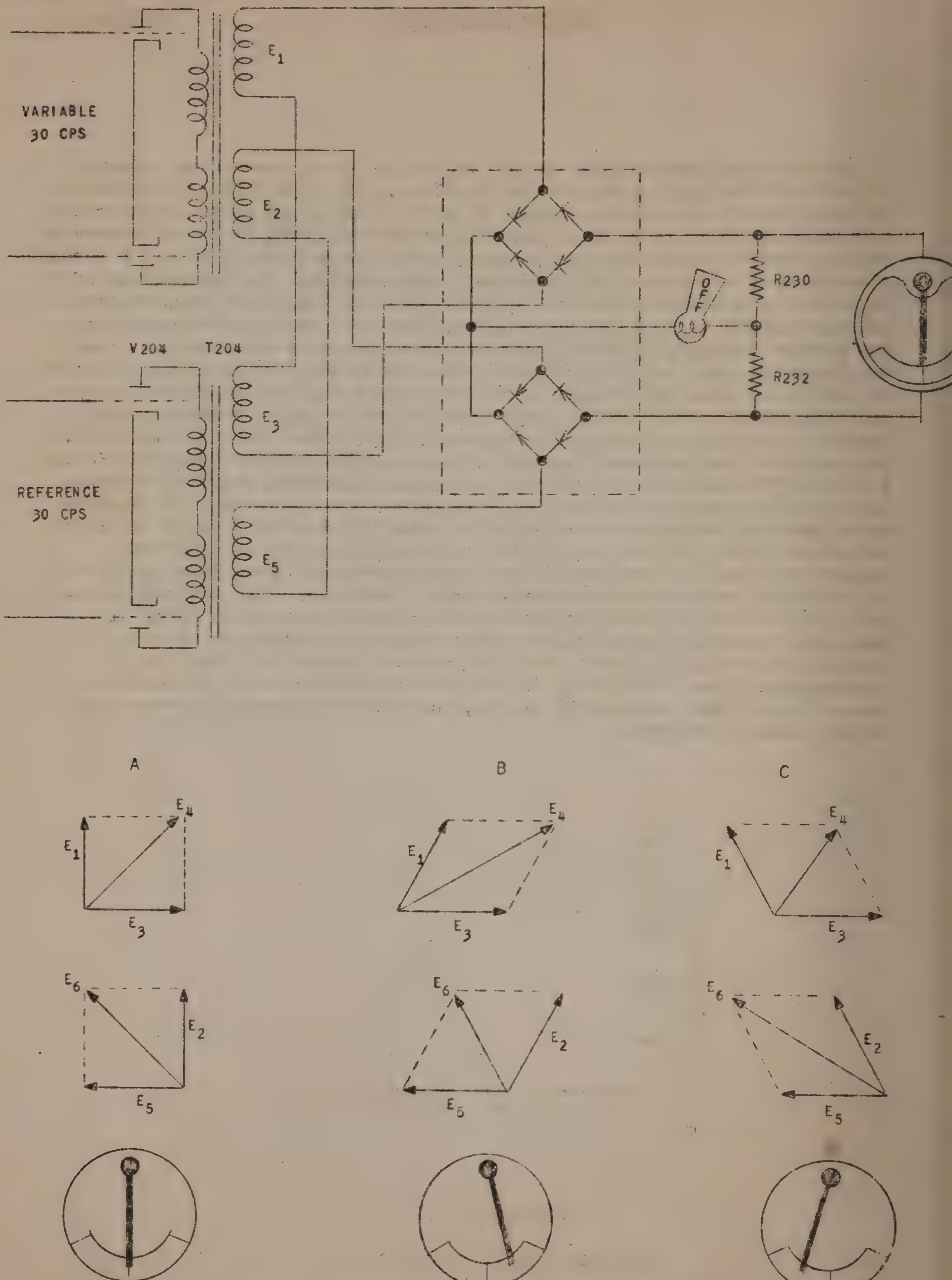


Figure 4-10 Deviation Indicator Circuit and Operation

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We have now traced the reference signal (the 10kc subcarrier carrying 30 cycles frequency modulation with a deviation ratio of 16) from the final detector of the r-f section through the input amplifier, limiter, discriminator (FM detector), phase splitting network, resolver feed tubes, resolver, and input transformer to the grids of V204 (one of the deviation indicator metering amplifiers) and V207 (the input amplifier of the omni-bearing selector servo amplifier). Leaving this signal at these two input transformers, we will now trace the reference 30 cycle signal from the detector onward through the instrumentation circuit.

Referring again to the 51R-1 Receiver schematic, we find diode load resistors R132 and R133 tapped at their junction with a wire feeding a 0.5 mf blockking capacitor, C131. This blocking capacitor is connected through terminal 11 of terminal board E101 to R252, the input resistance to the 30 cycle filter feeding the variable audio channel. The filter comprised of L202 and C241 is used as a parallel circuit resonated at 60 cycles. This combination produces high series impedance at 60 cycles and L202, operating in conjunction with C242, C243 and C244, serves as a series tuned 30 cycle circuit to feed grid 3 of V205. The use of the parallel tuned 60 cycle circuit as a series element gives high attenuation to 60 cycles while at the same time the use of L202 in a series tuned circuit gives resonant rise to the desired 30 cycle basic signal frequency for application to grid 3 of V205. The accompanying sketch shows the approximate attenuation characteristic of this filter. The purpose of the 30 cycle filter is to select the desired 30 cycle variable channel signal from all of the various noise, distortion, and propellor modulation frequencies present in the receiver diode detector output.

Tube V205 is connected as a phase inverter, transferring the single ended input applied to grid 3 to balanced output across plate load resistors R246 and R247 for application to the push pull grids of final metering amplifier V206. Transformer T205 couples V206 to the double bridge rectifier, E207. It will be seen now that V204, the reference channel output tube, is identical in plate circuit features to V206 and feeds through a similar transformer, T204, to the same pair of balanced bridge rectifiers, E207.

The metering circuit which operates the deviation indicator, ID-48, on the cockpit instrument panel is shown above. The 30 cycle variable signal, after passage through the filter and preamplifier stage, is delivered in push pull form to the grids of V206 where it is stepped up to approximately 60 volts, plate to plate, and passed through transformer T205 to the balanced meter rectifiers, E207. Reference 30 cycle signal, taken from 9960 cycle FM subcarrier, feeds in push pull form to the grids of V204 and thence to transformer T204 to rectifiers E207. Tracing the metering circuit we find in vector diagram A a vector diagram illustrating the addition of voltages which are rectified and fed to the deviation indicator. Voltage E1 from T205 is in quadrature and equal to voltage E3 obtained from the secondary of T204. These two voltages add together to produce voltage E4 which is

applied to rectifier E207. Voltage E2 adds to E5 to produce resultant voltage E6 which is applied to the other balanced rectifier in rectifier assembly E207. The outputs of the rectifiers E207 are fed to resistors R230 and R232 where their equal and opposite drops result in a zero center or null indication of the deviation indicator when the airplane is on-course to the station.

When the position of the airplane is changed relative to the desired track, the phase of the variable signal from the ground station is shifted with respect to the phase obtained from the reference channel transmitted via the sub-carrier. This change in phase is carridd through the metering amplifiers and results in a change in phase between the voltages feeding the balanced metering rectifiers in vector diagram B. Here we see vectors E1 and E2 rotated clockwise to the right a few degrees. The sum of E1 and E3 now produces the relatively long vector E4, while the sum of E2 and E5 shows up as the relatively short vector E6. It will be remembered that vectors E4 and E5 are rectified and converted to d-c where they are balanced against each other on a straight magnitude basis. The lack of balance between these two voltages as shown in diagram B results in an offset of the deviation indicator needle, thus showing that the airplane is not flying on the desired track.

Vector diagram C shows the vectors swung slightly in the opposite direction with a similar but opposite result. In this case the cross pointer needle will be moved in the opposite direction, indicating departure of the airplane in the opposite sense from the desired course line.

Referring again to the sketch, the flag alarm circuit is shown in combination with the basic deviation indicator rectifier circuit. The common current of the two balanced rectifiers flows through the flag alarm movement, resulting in this movement being pulled down whenever adequate signal currents are present in the metering circuit. Failure of either the reference or variable signals will allow the spring return movement to lift the flag into view thus obscuring the end of the vertical needle and showing the pilot that further useof the facility is dangerous due to lack of signal.

The pilot requires still another indicator in order to utilize properly the information from the ODR station. On flight along a course, passage over a station, and continued flight on the same radial beyond the station, the pilot's position with respect to the station has undergone a change. When on one side of the station, flying toward it, his magnetic bearing <u>TO</u> the station is, let us say 45 degrees. On passing over the station his magnetic bearing is now 45 degrees <u>FROM</u> the station. This piece of information is communicated to the pilot through the operation of the so-called ambiguity indicator which is a milliammeter movement operating a radium coated flag in the upper portion of the panel mounted omni-bearing selector. This so-called ambiguity indicator gets current for its operation from a phase detector-rectifier circuit connected to the metering output transformers of the basic navigation equipment

just described. In order to have this indicator flip over from TO to FROM at the proper time while the airplane is on course and passing over the station, the voltages feeding the ambiguity indicator phase detector are required to be 90 degrees different from the voltages feedingthe deviation indicator rectifier circuits.

Referring to the 51R-1 Receiver Schematic, transformer terminals 8,9, and 10 of transformers T204 and T205 are shown connected through rectifiers E206 and E205 to load resistors R228 and R229. The voltage developed across these latter resistors feeds out of the receiver through terminals 14 and 15 to the terminals of the ambiguity indicator located in the omni-bearing selector. This instrument has a scale range of 250-0-250 microamperes for full scale deflection and is required to reach full scale when the airplane has moved off a desired radial by approximately 20 degrees. When flying directly over a station this means that the ambiguity indicator will switch over from TO to FROM as the airplane crosses over the top of the station.

In order to achieve the desired operation the ambiguity indicator must be fed with 30 cycle voltages which are in phase at the same time the voltages leading to the deviation indicator are 90 degrees out of phase. This is accomplished through the use of center tapped windings 8, 9 and 10 on T205 through the circuit of phase splitting network R237 and C223. This circuit is illustrated in greater detail on the accompanying sketch. In this sketch C223, with a value of 1 mfd, is approximately equal in ohms to R237 at 6800 ohms. The vector diagram at A illustrates the action of this phase shifting circuit. Condenser and resistor voltage drops E_1 and E_2 add up at right angles, and in conjunction with the secondary voltages E_3 and E_4 produce the 90 degree vector E_5, which is fed down to the balance of the ambiguity indicator phase detector. The phase detector is simultaneously fed with voltages E_6 and E_7 from transformer T204 and these voltages in combination with E_5 produce net rectified output across resistors R228, R229 at all times except when the voltages in metering transformer T205 are in phase. The vector diagram B illustrates the operation of the ambiguity meter circuit and it will be seen that it is identical in principle to the balanced fullwave rectifiers which feed the basic vertical needle of the deviation indicator.

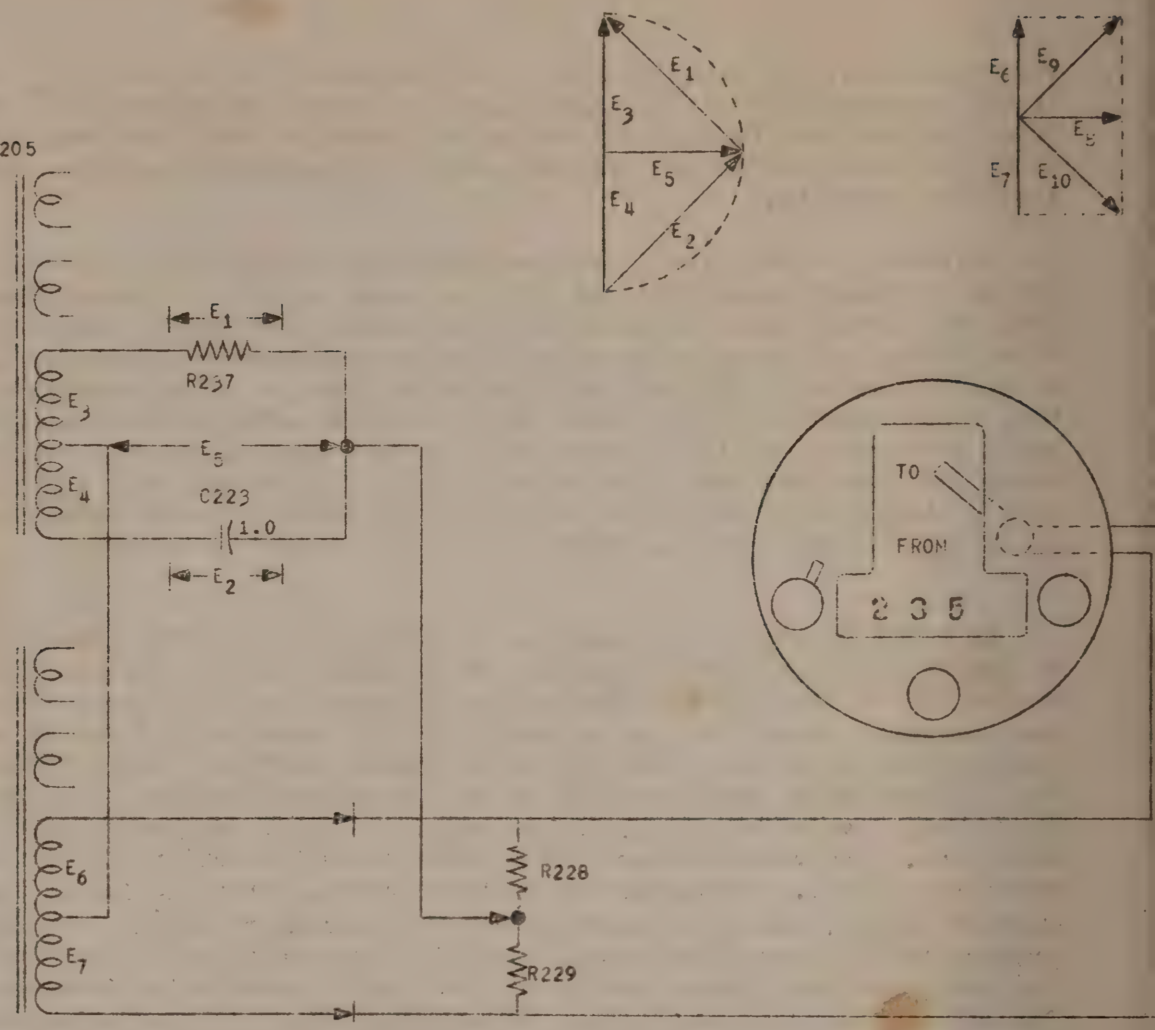


Figure 4-11 TO-FROM Indicator Circuit

AUTOMATIC CIRCUIT---OMNI-BEARING INDICATOR SERVO AMPLIFIER.

In addition to operating the deviation indicator, the flag alarm, and the ambiguity indicator in circuit with the omni-bearing selector, the indicator circuits must provide for operation of an automatic radial indicator called the omni-bearing indicator. Referring to the block diagram, the signal from the detector is separated into its 10 kc and 30 cycle components which are separately amplified and finally combined in the omni-bearing indicator servoamplifier. The 10 kc signal is filtered, amplified, limited, detected, split into quadrature components, and finally fed thru a cathode follower to the two stator coils of the automatic resolver in the omni-bearing indicator. At the same time the 30 cycle amplitude modulated signal (the

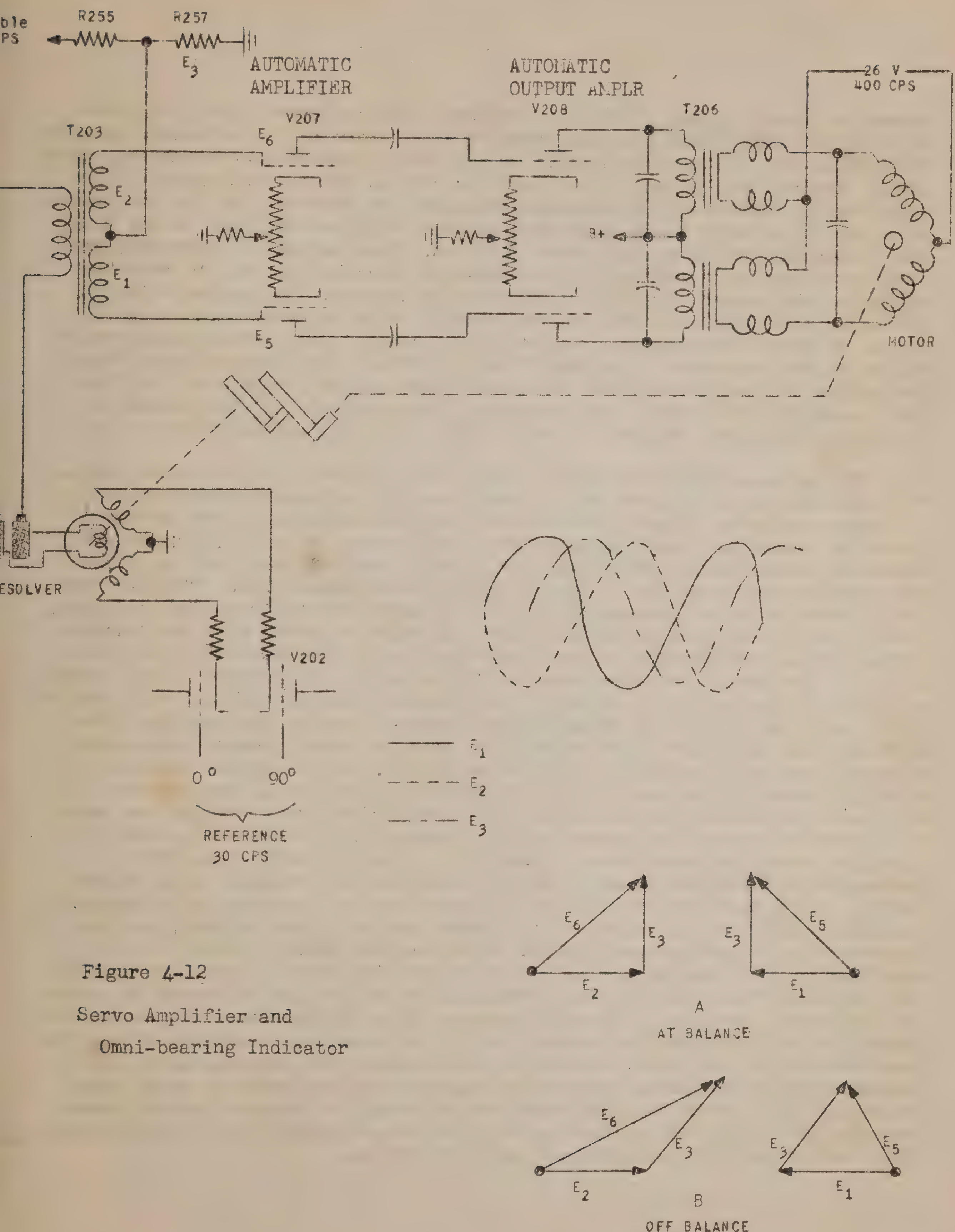


Figure 4-12

Servo Amplifier and
Omni-bearing Indicator

variable signal) is amplified and introduced into the servo amplifier where it combines with 30 cycle signal taken from the rotor of the automatic resolver. The combinaton of these two signals in a suitable phase detector circuit, actuates a control tube which in turn supplies current to the windings of a pair of saturable reactors. The saturable reactors are connected to the two phases of a 400 cycle servo motor which then rotates to drive the rotor of the automatic resolver around to its proper position. This action is continuous and results in automatic setting of the omni-bearing indicator dial to read the number of the radial on which the airplane is located. The omni-bearing indicator shaft carries a selsyn differential which is used to add magnetic angle taken from the magnetic compass to the radial angle automatically maintained by the omni-bearing indicator servo system. The combination of these two angles is then transmitted via normal selsyn means to the needle of the radio magnetic indicator in the cockpit. The needle of this instrument is thereby continuously oriented to point directly to the omni-station in use.

The accompanying sketch shows a simplified schematic of the servo amplifier and omni-bearing indicator. Signal from the reference channel feeds in quadrature to grids 3 and 7 of resolver feed tube, V202, and provides the necessary quadrature exciting currents to the stator coils of the automatic resolver in the omni-bearing indicator. The 30 cycle signal is taken from the resolver rotor and fed to the primary of transformer T203. Voltage from the 30 cycle variable channel is fed to a network consisting of R255 and R257. Voltage developed across this resistance is added in series with the voltages across the secondary coils of T203, and then fed in combination to the grids of V207. The vector diagram shows how the voltages are combined at the grids of V207. Voltages E_1, E_2 are taken from the secondaries of T203, while voltage E_3 is supplied from the 30 cycle variable channel through the resistor network starting with R255. The addition of these voltages produce resultants E_5 and E_6 which are applied to the grids of V207. The condition shown on the vector diagram at A allows the voltage existing to balance. The vector diagram at B shows the relationship of the vector when the airplane has moved a few degrees around the station and the servo amplifier is being given a signal to cause the servo motor to drive the resolver rotor around to a corresponding position. Here it will be seen that the relative size of vectors E_5 and E_6 appearing at the grids of V207 has been considerably changed, resulting in one of the halves of this tube passing a large signal, and the other passing a much reduced signal. These unequal signal voltages are amplified by V207 and applied to the grids of V208 which is biased to function as a balanced detector. The large increase in the voltage at one of the grids of V208 causes an increase in plate current drawn by that tube with consequent saturation of the control winding of one of the reactors comprising T206. The saturation of this reactor reduces the impedance of its corresponding a-c control winding, and sends currents through the motor circuit to cause motor rotation. The operation of the drive motor brings the resolver rotor around to a position of balance, thus restoring the vector diagram of A and bringing the resolver to rest on the proper radial position.

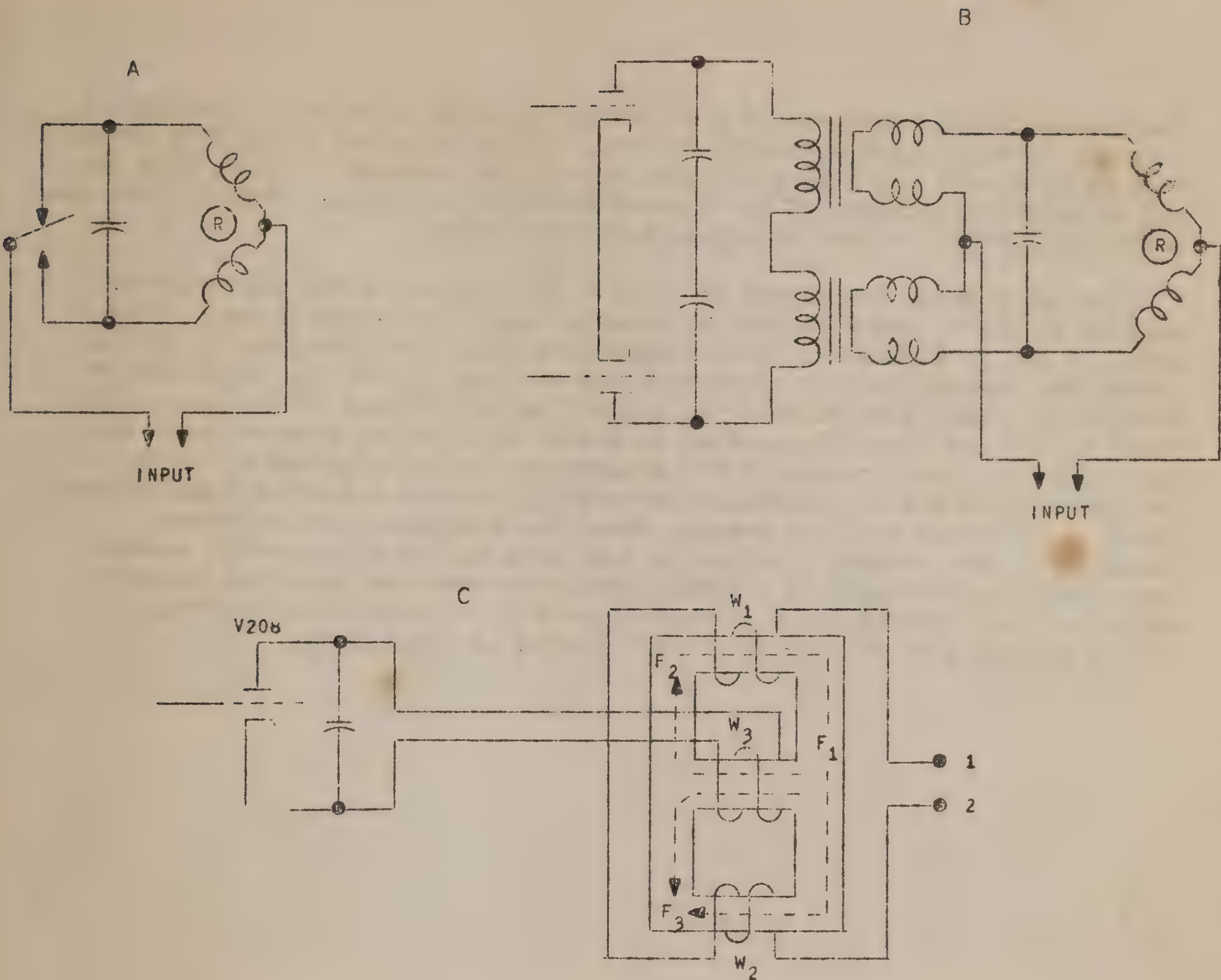


Figure 4-13 Typical Saturable Reactor

The servo motor circuit is shown above. Figure A of this sketch shows a basic condenser motor control circuit from which this circuit was adapted. In this simplified circuit, operation of the control switch to either contact connects one phase of the motor directly to the a-c supply line, and the other phase of the motor to the same supply line thru a condenser. The phase of the current through the condenser-fed phase can be made 90 degrees different from the line fed phase thru choice of a suitable sized condenser. The motor thus rotates clockwise. Operation of the motor control switch to the opposite contact reverses the phase conditions at the two motor coils resulting in opposite motor rotation. The sketch at B shows this same circuit arranged for vaccum tube control. Here the control switch is replaced by a pair of saturable reactors. These reactors have secondary windings of considerable

inductance, which inductance can be reduced by passage of d-c plate current thru the corresponding saturable winding. It is therefore clear that unbalance of grid voltages will cause unbalanced plate current to flow, thus unbalancing the inductance of the opposed saturable reactors. This in turn results in operation of the two-phase induction motor.

Sketch C shows the layout of winding in a typical saturable reactor. Winding W_1 and W_2 are wound on the outside legs of a 3-legged core. These windings are in series and their inductances add. The flux line F_1 flowing around the outside legs of the core links windings W_1 and W_2. When direct current is passed thru winding W_3, a d-c flux is produced which flows along lines F_2, F_3 and these fluxes rise to values which cause saturation of the core material. As a result of the saturation effect, windings W_1 and W_2 are greatly reduced in inductance and a still further reduction results from the loss of mutual coupling between these two windings. The impedance presented by the control windings to terminals 1-2 is thus greatly reduced and a low impedance path is provided for motor currents thru this reactor which has been saturated. A similar reactor is connected in opposition and is saturated by the opposite half of V208 as shown in B.

4.4. AUTOPOSITIONER.

The Collins Autopositioner is a mechanism which will set a shaft accurately to any one of several fixed positions by remote control. The mechanism is fast and quiet and is built for long dependable service. The shaft is driven by a motor through a torque limiting clutch. A relay controlled pawl engages a toothed wheel which is mounted on the shaft, thus stopping the shaft's rotation at a given position. The motor is controlled by the same relay that actuates the pawl. A tap switch is fastened to the positioned shaft, one switch position corresponding to each stop position. This switch, in cooperation with a remote control switch, operates the relay and selects the stop position. Any number of Autopositioners may be driven by a single motor, with independent remote control for each. There can be any number of stop positions for each shaft within practical manufacturing limits.

The 51R Receiver utilizes two Autopositioners of the twenty position style, driven by a common 28 volt d-c motor. The Autopositioners, motor, drive gears and auxiliary relay are all mounted on the front panel of the receiver. During normal operation the tuning mechanisms and control relays are covered by a dust cover that fastens to the front panel of the receiver.

The Autopositioner itself consists primarily of a relay with one set of normally open contacts, a pawl and toothed wheel arrangement and a clutch. The relay, in conjunction with the remote control circuits electrically controls the operation of the motor and mechanically controls the operation of the pawl. When two or more Autopositioners are driven by the same motor, one shaft will usually reach the selected position before the other. When one shaft has been positioned the pawl drops

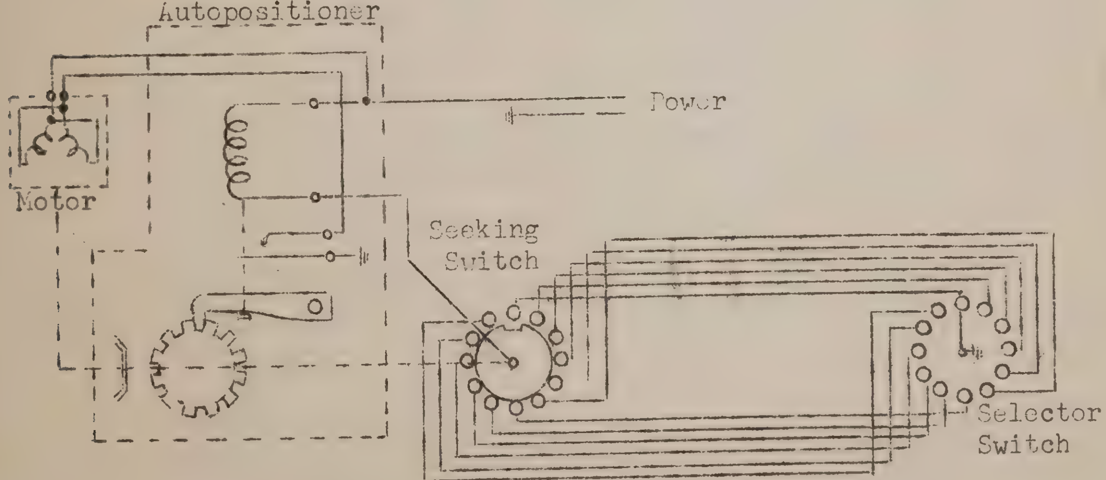


Figure 4-14 Simplified Autopositioner Control Circuit

into a slot in the toothed wheel and stops the shaft. The clutch on this first shaft will then slip until the second mechanism has been positioned. When the second Autopositioner has reached its home position, the relay opens, the pawl drops into the slot in the wheel, the motor primary circuit is broken and the motor stops.

A simplified version of the Autopositioner control circuit is shown in the accompanying sketch, figure 4-14. The control of the pawl and motor is based on the seeking switch rotating until the open segment of the switch finds the position corresponding to the position to which the remote control switch has been set. When the seeking switch finds this open position, the relay releases, drops the pawl into the slot in the toothed wheel, the motor circuit opens and the motor stops.

SECTION 5

MAINTENANCE

5.1. R-F CIRCUIT ALIGNMENT.

5.1.1. FIXED I-F AMPLIFIER ALIGNMENT.

(a) Equipment required.

(1) Signal generator of known accuracy with output on 3.2 mc.

(2) Vacuum tube voltmeter.

(3) A 47K ohm resistor and a 10K mmf capacitor (for "swamping" or loading the i-f transformer windings).

5.1.2. ALIGNMENT PROCEDURE.

NOTES

The fixed i-f amplifier (3.2 mc) transformers are slug tuned; transformer primary tuning at top of transformer, secondary tuning at the bottom. Best results obtained by "swamping" or loading transformer secondary when tuning primary and loading primary when tuning secondary. Combination of 4700 ohm resistor and 10,000 mmf capacitor in series used as load. Observe the stage-by-stage gain as the stages are progressively aligned. Check sensitivity against table of typical sensitivity measurements included in this section.

(a) Connect 4700 ohm resistor in series with a 10,000 mmf capacitor between plate of V107 (pin #5) and chassis.

(b) Connect voltmeter to AVC line.

(c) Couple output of signal generator (3.2 mc) to grid of V107 (pin #1).

(d) Tune secondary of transformer T108 for maximum AVC voltage.

(e) Remove resistor and capacitor from primary of T108 and connect across secondary of same transformer, between pin #3 or #4 of V108 and chassis.

(f) Tune primary of T108 for maximum AVC voltage.

(g) Repeat steps (a) thru (f) above for 1st and 2nd i-f stages, V105 and V106. Tune primaries and secondaries of T107, T106 and T105, in that order, for maximum AVC voltage.

(h) When alignment has been completed, check to determine if response is uniform on both sides of 3.2 mc by varying the output frequency of the signal generator on either side of 3.2 mc and observing the variation in AVC voltage.

5.1.3. VARIABLE I-F AMPLIFIER ALIGNMENT.

(a) Equipment Required.

(1) Signal generator covering frequency range 19.5 to 21.4 mc.

(2) Vacuum tube voltmeter.

NOTES

Transformers T103, T104 and T113 are slug tuned with powdered iron slugs suspended from table that can be raised and lowered. The alignment consists of positioning the slugs with respect to the position of the table.

5.1.4. ALIGNMENT PROCEDURE.

(a) Operate the fine frequency Autopositioner to 0.9 mc.

(b) Tune the signal generator to 20.5 mc.

(c) Couple the output of the signal generator to the grid of V104 (pin #1) and couple the voltmeter to the AVC line.

(d) Tune the signal generator until the voltmeter indicates maximum AVC voltage.

(e) Tune both slugs in T113 for maximum AVC voltage. Couple the output of the signal generator to the grid of V103 and tune T104 for maximum AVC voltage.

(f) Couple output of signal generator to grid of V102 (pin #1) and tune slugs in T103 and T104 for maximum AVC voltage.

(g) Check overall sensitivity of i-f amplifiers both variable and fixed. Check results against table of typical sensitivity measurements supplied.

(h) Operate fine frequency Autopositioner to 0.0 position, apply 19.5 mc signal to V102 grid (pin #1) and check the sensitivity.

(i) Operate fine frequency Autopositioner to 1.9 mc position, apply 21.5 mc signal to grid of V102 and check sensitivity.

5.2. R-F AMPLIFIER GRID, FIRST MIXER AND H-F INDUCTOR ALIGNMENT.

5.2.1. Equipment Required.

(a) Signal generator covering frequency range 108 to 135 mc.

(b) Vacuum tube voltmeter.

NOTES

R-F amplifier grid transformer T101 has only one tuned circuit while transformers T102, T111 and T112 each include a primary and a secondary. These circuits are tuned by powdered iron core slugs mounted on a movable table. The alignment consists of positioning the slugs with respect to the slug table. A trimmer capacitor is connected across each winding. These trimmer capacitors are accessible thru openings in the front of the transformers.

5.2.2. PROCEDURE.

(a) Tune transformer T112 first.

(b) Operate Autopositioners until combination of indicator readings equals 108.9 mc.

(c) Set trimmer capacitors to about one-half capacity (slots in capacitors vertical).

(d) Couple vacuum tube voltmeter to grid of V111 (pin #1).

(e) Tune slugs in both primary and secondary of T112 for maximum V111 grid voltage.

(f) Operate Autopositioners to tune receiver to 134.9 mc and tune trimmer capacitors for maximum V111 grid voltage.

(g) Repeat steps (b) thru (f) above until it is impossible to obtain any further increase in V111 grid voltage by adjusting the tuning slugs and trimmer capacitors.

(h) To align T111 repeat procedure outlined for T112 but instead of tuning for maximum V111 grid voltage, couple the vacuum tube voltmeter to the grid of V102 (pin #1) and adjust slugs and trimmer capacitors in T111 for maximum V102 grid voltage.

(i) To adjust T102, operate Autopositioners to 108.9 position.

(j) Connect output of signal generator to antenna post.

(k) Couple vacuum tube voltmeter to AVC line.

(l) Set trimmer capacitors at one-half capacity (slot in capacitor vertical).

(m) Tune slugs in primary and secondary of T102 for maximum AVC voltage.

(n) Operate Autopositioners to 134.9 mc, tune signal generator to 134.9 mc and tune trimmer capacitors for maximum AVC voltage.

(o) Repeat steps(i) thru (n) until it is impossible to obtain any further increase in AVC voltage by adjusting the tuning slugs and trimmer capacitors.

(p) To align r-f transformer T101, feed a 108.9 mc signal into the antenna circuit as indicated for the alignment of T102 above and with the Autopositioners positioned at 108.9 mc, tune the slug for maximum AVC voltage.

(q) Operate Autopositioners and signal generator to 134.9 mc and adjust trimmer capacitor.

(r) Repeat steps (p) and (q) until it is impossible to obtain any increase in AVC voltage.

The above procedures complete the alignment of the r-f section. Check sensitivity and selectivity against tables of typical data supplied. Repeat above procedure if sensitivity is low.

Table 5-1

TYPICAL R-F SENSITIVITY OF 51R-1 VHF RECEIVER

Sensitivity for 1.0 v d.c. on AVC Line*
Measured with a Vacuum Tube Voltmeter.

Location	Function	Frequency (mc)	Typical Sensitivity (uv)
Antenna	-	108 - 136	1.
V101.1	R-F Amplr	108 - 136	2.5
V102.1	1st Mixer	19.5 - 21.4	9
V103.1	Ver. Freq. I-F Amplr	19.5 - 21.4	20
V104.1	2nd Mixer	19.5 - 21.4	150
V104.1	2nd Mixer	3.2	250
V105.1	1st Fixed I-F	3.2	850
V106.1	2nd Fixed I-F	3.2	9,000
V107.1	3rd Fixed I-F	3.2	100,000
V108.2	Aural Det.	d.c.	4.2 v **

* R-F sensitivity control set for maximum sensitivity
** With r-f signal at V107.1 to give 1.0 v on AVC line

Table 5-2

TYPICAL I-F SELECTIVITY

Conditions of Measurement:

1. 3.2 mc signal, modulated at 1000 cps introduced into grid of second mixer.

2. Output - 50 milliwatts

3. Input raised 2, 10, 100 and 1000 times the input at 3.2 mc as the signal generator was tuned off resonance enough to bring the output back to 50 milliwatts.

4. 28 v d.c. input to power supply

DB Change In Input Signal	Frequency In Kilocycles
6.0	- 26.9, + 25.0
20.0	- 41.3, + 35.8
40.0	- 61.0, + 52.5
60.0	- 82.0, + 72.6

Table 5-3

AVC CHARACTERISTIC

Conditions of Measurement:

1. Input - 115.2 mc modulated 30% at 400 cps fed into antenna terminal

2. Input level - varied from 1 microvolt to 100,000 microvolts

3. 28 v d.c. to power supply

Input Signal Microvolts	Audio Output mw	Audio Output Rel DB	DB Power Change from 250 mw	% Distortion and Noise
1	140	11.2	-2.8	35
2	190	12.6	-1.4	20
3	200	13.0	-1.0	15.5
5	220	13.3	-0.7	12.5
7	230	13.5	-0.5	12.5
10	235	13.7	-0.3	12.5
30	250	14.0	0	12.0
100	250	14.0	0	11.7
300	260	14.1	+0.1	11.0
1000	260	14.1	+0.1	11.0
3000	260	14.1	+0.1	11.0
10000	265	14.2	+0.2	10.5
100000	285	14.5	+0.5	12.0

Table 5-4

A-F RESPONSE

Conditions of Measurements:

1. Input - 1000 microvolts fed into antenna terminal. Frequency varied from 30 to 10,000 cps. Percentage of modulation held constant.

2. 28 v d.c. to power supply.

At 108 mc* DB	Output Rel DB	Audio Freq. in cycles	At 131.8 mc* DB	Output Rel DB
-23.0	-39.5	30	-25.0	-38.5
-22.0	-38.5	90	-24.0	-37.4
-21.0	-37.5	100	-24.0	-37.4
-19.0	-35.5	150	-24.0	-37.4
- 3.5	-19.0	200	- 9.0	-22.4
+13.8	- 2.7	300	+ 9.0	- 4.4
+16.1	- 0.4	400	+11.5	+ 1.9
+16.4	- 0.1	600	+12.6	- 0.8
+16.5	0	800	+13.2	- 0.2
+16.5	0	1000	+13.4	0
+16.5	0	1250	+13.5	+ 0.1
+16.2	- 0.3	1500	+13.5	+ 0.1
+15.6	- 0.9	2000	+13.0	- 0.4
+12.0	- 4.5	3500	+10.0	- 3.4
+ 7.0	- 9.5	5000	+ 6.5	- 6.9
- 8.0	-24.5	10000	- 8.0	-21.4

* At 108 megacycles the input was modulated at 30% while at 131.8 megacycles it was modulated 100%.

Table 5-5

OMNI-RANGE PERFORMANCE

A. Azimuth accuracy 1000 uv ODR sig.

Crosspointer $\pm 0.75^\circ$ to 1°
OBI $\pm 1.0^\circ$ to 1.5°

Crosspointer reciprocal error, 0.5 to 0.75°

B. Course Sensitivity

Crosspointer deflection for 10° off course
140 to 155 uv
OBI sensitivity: minimum course change to which the OBI will respond. 0.5°

c. ODR Stability:

		Crosspointer	OBI
RF Signal Level	5 uv	0 to $\pm 0.5^\circ$	0 to $\pm 0.5^\circ$
	1000 uv	0	0
	100,000 uv	0 to $\pm 1.0^\circ$	0 to $\pm 0.5^\circ$
Modulation level			
	22%	0 to $\pm 1.0^\circ$	0 to $\pm 1.0^\circ$
	30%	0	0
	38%	0 to $\pm 1.0^\circ$	0 to $\pm 1.0^\circ$
Line Voltage	-10%	0 to $\pm 0.5^\circ$	0 to $\pm 1.0^\circ$
	Normal	0	0
	+10%	0 to $\pm 0.5^\circ$	0 to $\pm 1.0^\circ$

Table 5-6

LOCALIZER PERFORMANCE

A. Sensitivity 1000 uv localizer signal

1. Tone localizer 150 cps and 90 cps
   Modulation in ratio of 4 db
   Crosspointer selection 90 to 95 u amp

2. Phase localizer 30% reference signal modulation,
   7.5% variable phase signal modulation
   Crosspointer deflection 90 to 95 u amp

B. Accuracy

1. Each set adjusted for zero
   Crosspointer with an on-course signal.

Table 5-7

TYPICAL VOLTAGES (ESTIMATED)

NDICATOR CIRCUIT

art A

Omni-Range Operation

Test equipment

Electronic AC voltmeter Ballentine Model 300 or equivalent. Cord capacity must be less than 50 mmf when measuring 10kc signals and less than 300 mmfd when measuring 30 cycle signals.

Test conditions

Line voltage to 51R - 27.5 volts d-c
26 volts 400 cycles
Input to receiver - 1000 volts on 114.9 mc normal VOR modulation
479S-1 test equipment set to 0°, 336-A track selector set to 0°,
Deviation indicator at balance.

All voltages measured to chassis ground. Tolerance ±15%.

Indicator Circuit Input

Terminal 10 Interunit board 1.1
Terminal 11 Interunit board .25

Reference Channel 10 kc amp and limiter

TUBE	PIN	VOLTAGE
V201	2	.06
V201	3	0.4
	4	9.0
	5	GND
	6	42
	7	2.3
	8	.3

Manual Resolver Feed

TUBE	PIN	VOLTAGE
V202	2	1.8
	3	1.7
	4	0 B+
	5	0 GND
	6	0 B+
	7	1.2
	8	1.8

Automatic Resolver Feed

TUBE	PIN	VOLTAGE	
V203	2	1.8	
	3	1.7	
	4	0	B+
	5	0	GRD
	6	0	B+
	7	1.2	
	8	1.8	

Manual Resolver

Stator Side R225 0.3
Stator Side R280 0.3
Rotor, Terminal 13 interunit board .13

Automatic Resolver

Stator Side R211 0.2
Stator Side R278 0.2
Rotor Side R253 .07

Reference Output Amp

TUBE	PIN	VOLTGE
V204	2	0.1
	3	1.0
	4	21
	5	GND
	6	21
	7	1
	8	0.1

Variable Phase Channel Variable Phase Amp.

TUBE	PIN	VOLTAGE
V205	2	0.1
	3	0.2
	4	2.5
	5	GND
	6	2.5
	7	.2
	8	.1

Variable Phase Output

TUBE	PIN	VOLTGE
V206	2	0.3
	3	1.7
	4	30
	5	G D
	6	30
	7	1.7
	8	.3

Metering Circuit

	PINS	VOLTAGE
E207	2-3	6.0
	6-9	6.0

Automatic Servo
Phase Detector Input
Reference Phase T203 Side R253
0.07 volts

Variable Phase, @ Buss wire on Automatic Terminal Board, 2.5 v.

Automatic Amplifier

TUBE	PIN	REFERENCE VOLTAGE ONLY	VARIABLE VOLTAGE ONLY	NORMAL INPUT
V207	2	.08	1.5	1.6
	3	0.6	1.9	2.0
	4	15	23	26.0
	5	GND	GND	GND
	6	15	23	26
	7	0.6	1.9	2.0
	8	.08	1.5	1.6

Automatic Output Amplifier

TUBE	PIN	REFERENCE VOLTAGE ONLY	VARIABLE VOLTAGE ONLY	NORMAL INPUT
V208	2	.5	0.7	.7
	3	15	23	26
	4	7.0	10	11
	5	GND	GND	GND
	6	7.0	10	11
	7	15	23	26
	8	.5	0.7	.7

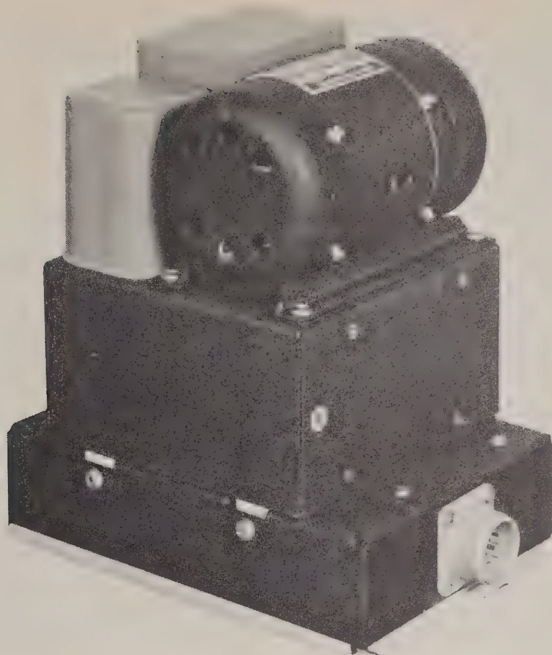
Part B

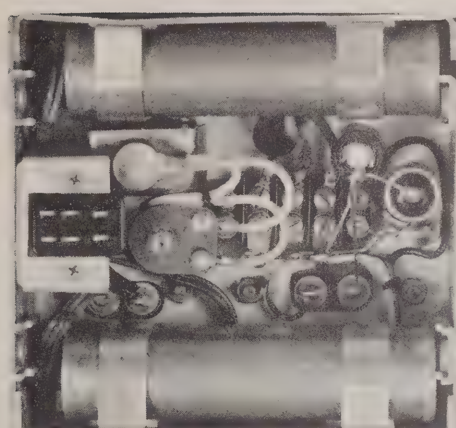
D.C. volts to ground. Primary voltage input 27.5 D.C. ODR signal 114.9 mc 1000 mv 400 cycles off. Tolerance ±15%.

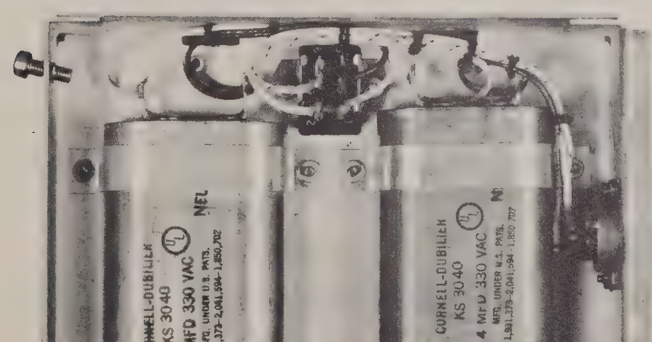
TUBE	PIN NO.	VOLTS 20,000 ohm/v (Estimated)	VOLTS VTVM (Estimated)
V201	1	6.1	
	2	1.6	
	3		0
	4	80	
	5	GND	
	6	245	
	7		3.5
	8	7.3	
	9	12.3	
V202	1	20.5	
	2	5.0	
	3		0
	4	245	
	5	GND	
	6	245	
	7		0
	8	5.0	
	9	14.7	
V203	1	6.1	
	2	5.0	
	3		0
	4	245	
	5	GND	
	6	245	
	7		0
	8	5.0	
	9	12.3	
V204	1	20.5	
	2	5.3	
	3		0
	4	240	
	5	GND	
	6	240	
	7		0
	8	5.3	
	9	14.7	
V205	1	20.5	
	2	1.4	
	3		0
	4	60	

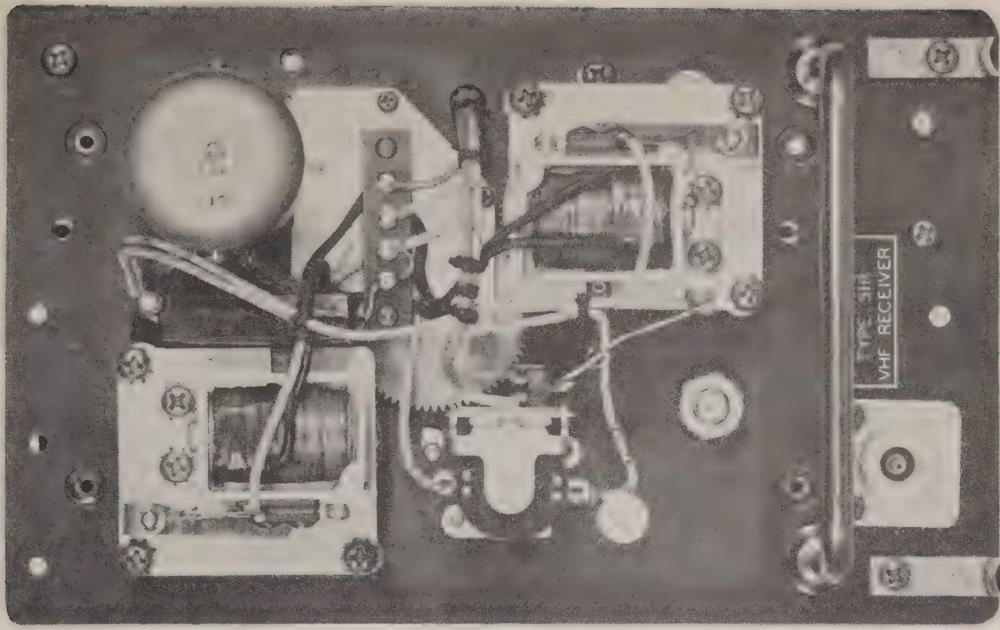
TUBE	PIN NO.	VOLTS 20,000 ohm/v (Estimated)	VOLTS VTVM (Estimated)
	5	GND	
	6	60	
	7		0
	8	1.4	
	9	26.7	
V206	1	6.1	
	2	5.3	
	3.		0
	4	240	
	5	GND	
	6	240	
	7		0
	8	5.3	
	9	0	
V207	1	20.5	
	2	4.5	
	3		0
	4	165	
	5	GND	
	6	165	
	7		0
	8	4.5	
	9	26.7	
V208	1	6.1	
	2	43	
	3		0.4
	4	240	
	5	GND	
	6	240	
	7		0.4
	8	43	
	9	0	
Terminal Posts (Bottom of Tube Shelf, Numbered Front to Rear)			
	1	4.0	
	3	245	
	7	40	
Top	R271	2.9	

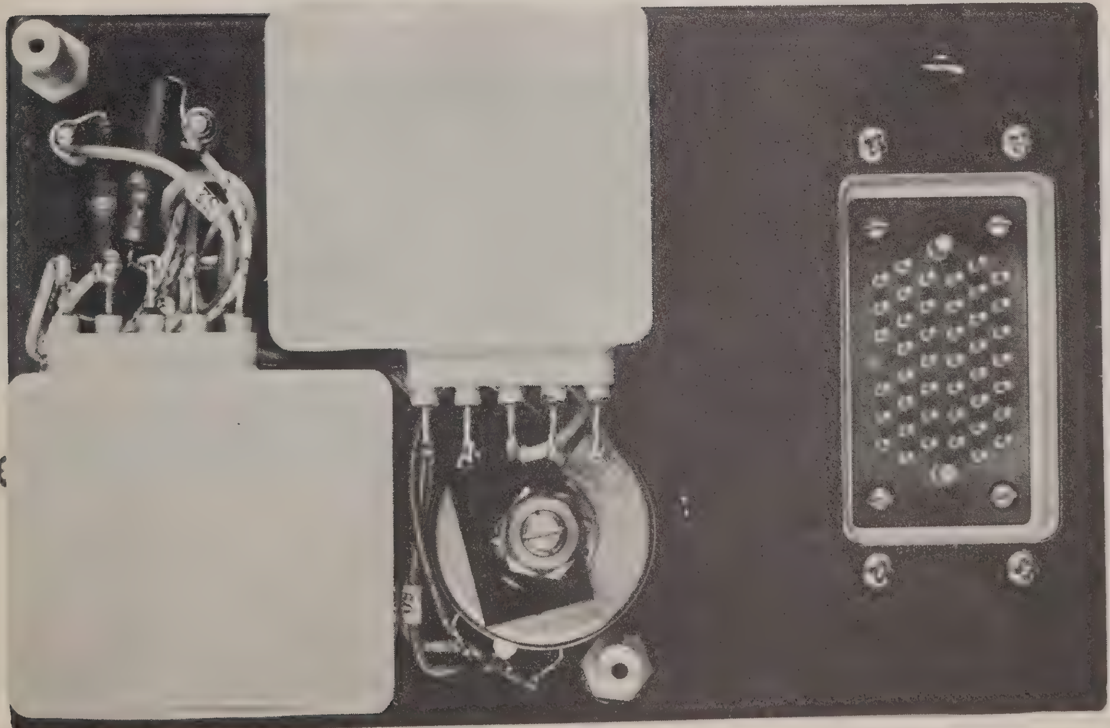
NOTE: At an early date these values where necessary will be revised to conform to production data.

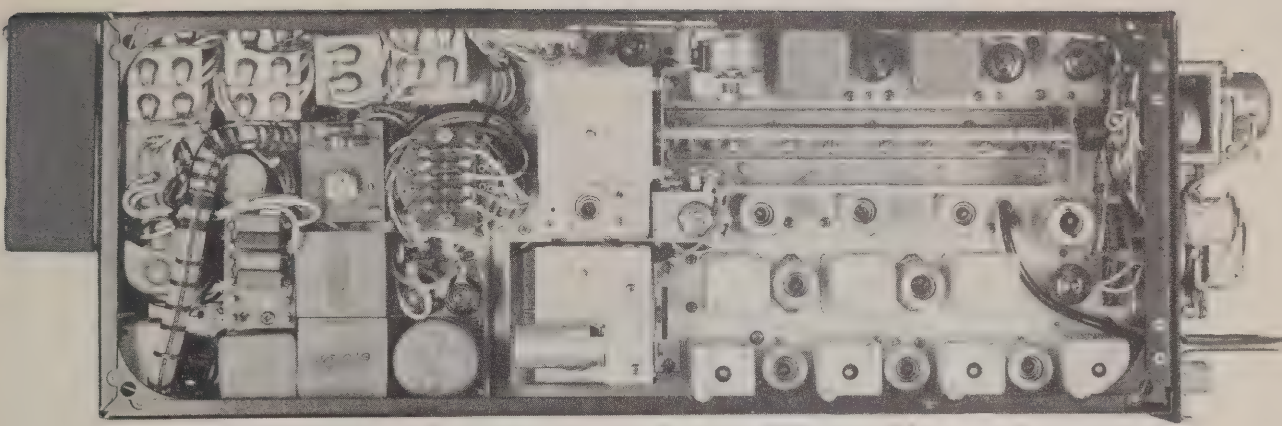


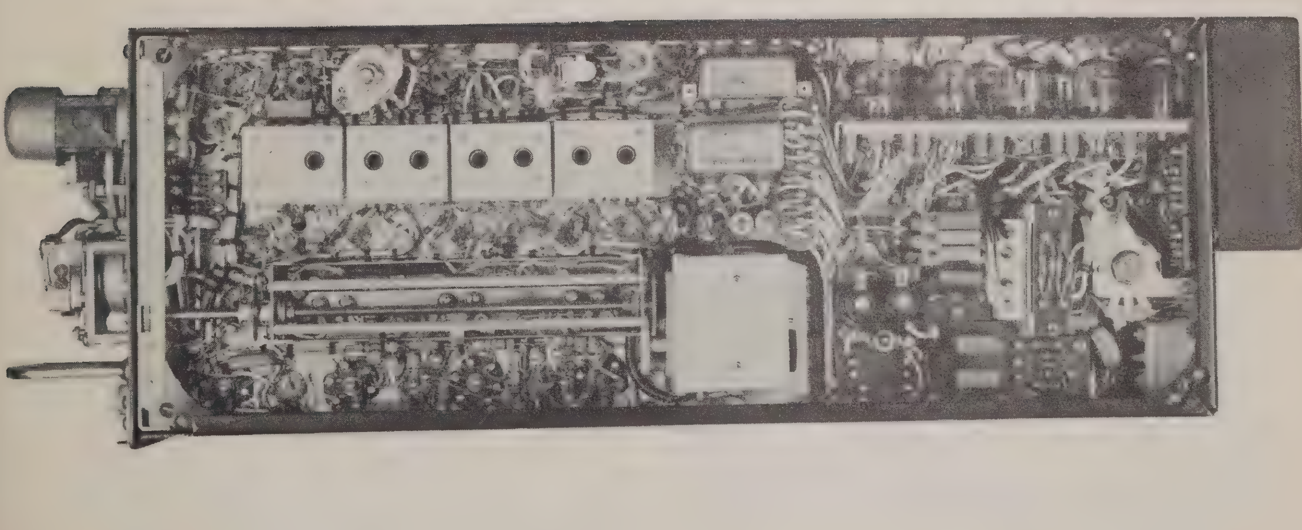


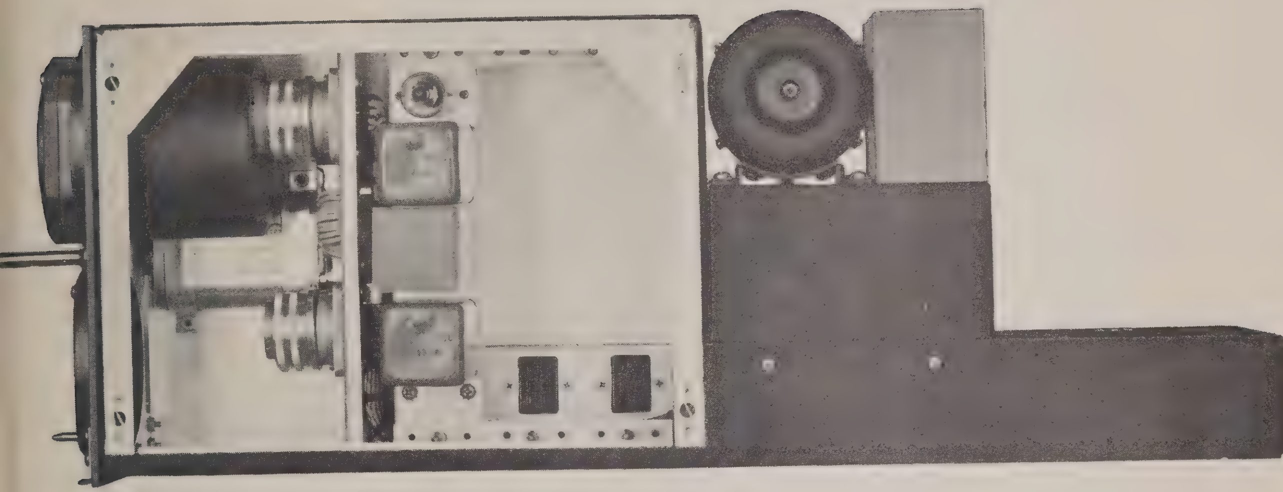

CORNELL-DUBILIER
KS 3040
MFD 330 VAC
CORNELL-DUBILIER
KS 3040
4 MFD 330 VAC

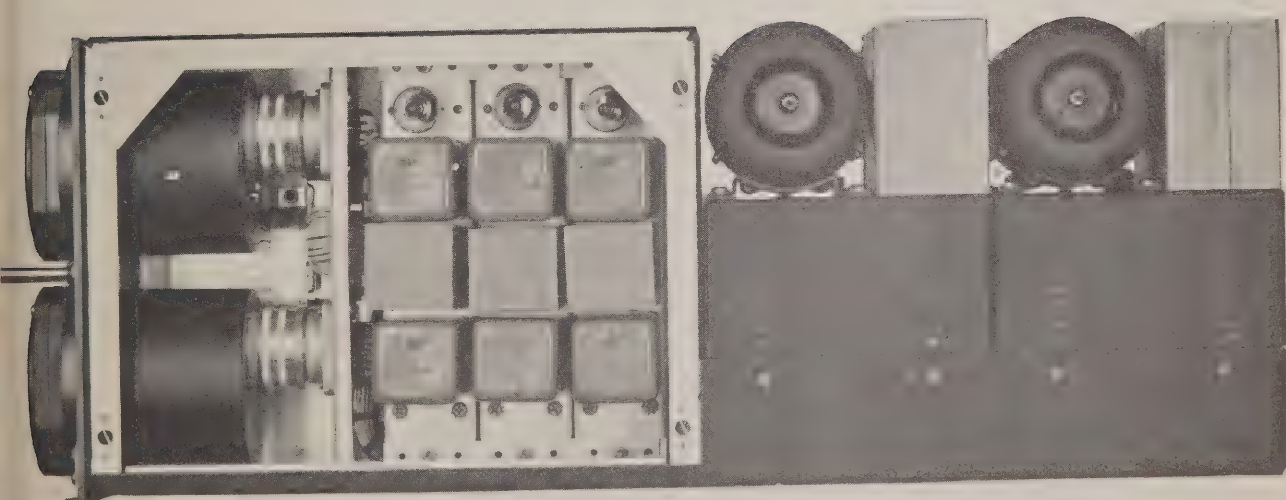

VHF RECEIVER











ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
B101	Autopositioner	MOTOR: DC, PM; 27.5 vdc input; 1200 rpm	503 5082 002
C101	R-F amp AVC filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C102	R-F amp grid coupling	CAPACITOR, Ceramic: 10 mmf ±1/4 mmf, 500 WV	913 0528 00
C103	R-F amp cathode bypass	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0420 00
C104	R-F amp screen bypass	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0420 00
C105	1st mixer excitation coupling	CAPACITOR, Ceramic: 2.2 mmf ±20%, 500 WV	913 0390 00
C106	1st mixer grid coupling	CAPACITOR, Ceramic: 24 mmf ±5%, 500 WV	916 4428 00
C107	1st mixer cathode bypass	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0420 00
C108	1st mixer screen bypass	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0420 00
C109	1st mixer screen voltage filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C110	Variable i-f amp AVC filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C111	Variable i-f amp cathode bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C112	Variable i-f amp screen bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C113	Variable i-f amp plate voltage filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C114	R-F section h-v voltage filter	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0301 00
C115	Low freq injection osc plate tank	CAPACITOR, Silver Mica: 1000 mmf ±5%, 500 WV	912 0393 00
C116	2nd mixer screen by-pass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C117	2nd mixer plate voltage filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C118	1st fixed i-f amp AVC filter	CAPACITOR, Ceramic: 1500 mmf ±20% 350 WV	913 0393 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C119	1st fixed i-f amp cathode bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 C
C120	1st fixed i-f amp screen bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 0
C121	1st fixed i-f amp hv filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 0
C122	2nd fixed i-f amp grid coupling	CAPACITOR, Ceramic: 4.7 mmf ±20%, 500 WV	913 0392 0
C123	2nd fixed i-f amp cathode bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 0
C124	2nd fixed i-f amp screen bypass	CAPACITOR, Paper: 50,000 mmf ±20%, 120 WV	934 0021 0
C125	2nd fixed i-f amp plate voltage filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 0
C126	3rd fixed i-f amp AVC filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 0(
C127	3rd fixed i-f amp h-v filter	CAPACITOR, Mica: 10,000 mmf ±10%, 300 WV	935 2117 0(
C128	3rd fixed i-f amp screen bypass	CAPACITOR, Mica: 10,000 mmf ±10%, 350 WV	935 2117 0(
C129	1st fixed i-f amp grid coupling	CAPACITOR, Ceramic: 10 mmf ±1/4 mmf, 500 WV	913 0528 0(
C130	1st fixed i-f amp grid coupling	CAPACITOR, Ceramic: 10 mmf ±1/4 mmf, 500 WV	913 0528 0(
C131	Detector output coupling	CAPACITOR, Paper: .5 mf ±10%, 600 WV	930 0130 0(
C132	Detector output filter	CAPACITOR, Ceramic: 100 mmf ±10%, 500 WV	916 4003 00
C133	AVC rectifier coupling	CAPACITOR, Ceramic: 100 mmf ±10%, 500 WV	916 4003 00
C134	AVC rectifier cathode bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C135	L-F injection osc screen bypass	CAPACITOR, 1500 mmf	

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C136	Noise limiter coupling	CAPACITOR, Mica: 10,000 mmf ±10%, 300 WV	935 2117 00
C137, C137A, C137B, C137C	C137A, C137B, C137C Noise limiter network 1st audio amp cathode bypass	CAPACITOR, Paper: .5/.5/.5 mf ±20%, 100 WV	931 0030 00
C138	Noise limiter cathode bypass	CAPACITOR, Mica: 470 mmf ±10%, 500 WV	935 0134 00
C139	1st audio amp grid coupling	CAPACITOR, Mica: 10,000 mmf ±10%, 300 WV	935 2117 00
C140	Audio output amp cathode bypass	CAPACITOR, Paper: 4 mf -20 +30%, 100 WV	931 0035 00
C141	Squelch control grid bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C142	Communications audio output filter	CAPACITOR, Mica: 4700 mmf ±10%, 500 WV	935 2103 00
C143	HF injection osc cathode bypass	CAPACITOR, Mica: 220 mmf ±20%, 500 WV	935 0121 00
C144	HF injection osc feedback coupling	CAPACITOR, Ceramic: 20 mmf ±2%, 500 WV	916 4054 00
C145	HF injection osc screen bypass	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C146	HF injection mult input coupling	CAPACITOR, Ceramic: 15 mmf ±2%, 500 WV	913 0534 00
C147	HF injection mult cathode bypass	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0420 00
C148	HF injection mult screen bypass	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0420 00
C149	HV filter	CAPACITOR, Mica: 10,000 mmf ±20%, 350 WV	935 5009 00
C150	Bias osc output filter	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C151	L-F injection osc cathode bypass	CAPACITOR, Mica: 220 mmf ±20%, 500 WV	935 0121 00
C152	L-F injection osc feedback coupling	CAPACITOR, Ceramic: 20 mmf ±2%, 500 WV	916 4054 00
C153	Audio grid decoupling	CAPACITOR, Mica: 470 mmf ±10%, 500 WV	935 0134 00
C154, C154A, C154B, C154C,	C154A, C154B, C154C Bias osc output filter Bias osc h-v filter Bias osc h-v filter	CAPACITOR, Paper: .1/.1/.1 mf ±20%, 600 WV	961 5057 00
C155	Bias osc grid coupling	CAPACITOR, Mica: 100 mmf ±20%, 500 WV	935 0107 00
C156	AVC amp grid bypass	CAPACITOR, Paper: 50,000 mmf ±20%, 120 WV	934 0021 00
C157	R-F section h-v filter	CAPACITOR, Silver Mica: 1500 mmf ±20%, 350 WV	913 0393 00
C158	R-F section h-v filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C160	Filament voltage filter	CAPACITOR, Silver Mica: 500 mmf ±20%, 500 WV	912 0301 00
C161	L-F injection osc plate h-v filter	CAPACITOR, Ceramic: 1500 mmf ±20%, 350 WV	913 0393 00
C163	Motor capacitor	CAPACITOR, Paper: 200,000 mmf ±20%, 120 WV	931 0151 00
C201	Reference channel input filter	CAPACITOR, Mica: 220 mmf ±20%, 500 WV	935 0121 00
C202	V201 cathode bypass	CAPACITOR, Paper: .1 mf -20 +30%, 200 WV	931 0208 00
C203	V201 grid coupling	CAPACITOR, Mica: 10,000 mmf ±10%, 300 WV	935 2117 00
C204	V201 cathode bypass	CAPACITOR, Paper: .1 mf -20 +30%, 200 WV	931 0208 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C205	Discriminator reactor tuning	CAPACITOR, Mica: 1500 mmf ±2%, 500 WV	935 2336 00
*C206	Discriminator reactor tuning	CAPACITOR, Mica:	
C207	Discriminator load resistor bypass	CAPACITOR, Mica: 1,000 mmf ±20%, 500 WV	935 4054 00
C208	Discriminator load resistor bypass	CAPACITOR, Mica: 1,000 mmf ±20%, 500 WV	935 4054 00
C209	Discriminator output coupling	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00
C210	Discriminator output coupling	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00
C211	Phase splitting network	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C212	Phase splitting network	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C213	Phase splitting network	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C214	Phase splitting network	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
*C219	V204 grid	CAPACITOR, Mica:	
C220	V204 grid	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C221	V204 plate	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00
*C222	V204 plate	CAPACITOR, Mica:	
C223	Variable channel output coupling	CAPACITOR, Paper: 1 mf ±10%, 600 WV	930 0080 00
*C224	V206 plate	CAPACITOR, Mica:	
C225	V206 plate	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00
C226	Variable channel 1st amp output coupling	CAPACITOR, Paper: .50 mf ±10%, 400 WV	930 0069 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C227	Variable channel 1st amp output coupling	CAPACITOR, Paper: .50 mf ±10%, 400 WV	930 0069 0(
C228	Variable channel 1st amp plate filter	CAPACITOR, Paper: 2 mf +40 -15%, 600 WV	930 0023 0(
C229		CAPACITOR: Not used	
C230	V208 cathode bypass	CAPACITOR, Dry Electrolytic: 50 mf	184 6523 0(
C231	V207 grid	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 0(
C232		CAPACITOR: Not used	
C233	V207 output coupling	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00
C234	V207 output coupling	CAPACITOR, Paper: .25 mf ±10%, 400 WV	930 0089 00
C235	V208 plate	CAPACITOR, Paper: 1 mf ±10%, 600 WV	930 0080 00
C236	V208 plate	CAPACITOR, Paper: 1 mf ±10%, 600 WV	930 0080 00
C237	V208 output filter	CAPACITOR, Paper: 2 mf -20 +30%, 100 WV	931 0034 00
C239		CAPACITOR: Not used	
C240		CAPACITOR: Not used	
C241	Variable channel input filter	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C242	Variable channel input filter	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C243	Variable channel input filter	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
C244	Variable channel input filter	CAPACITOR, Mica: 10,000 mmf ±2%, 300 WV	935 2391 00
*C245	Variable channel input filter	CAPACITOR, Mica:	
E101	Receiver connector	BOARD, Terminal: 19 solder term	503 5768 00]
E102	Receiver connector	BOARD, Terminal: 13 term	
E201	Bias rectifier	RECTIFIER, Crystal: germanium; min forward cur 3 ma at 1 v; max reverse cur 1 ma at 50 v	353 0011 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
E202	Bias rectifier	RECTIFIER, Crystal: germanium; min forward cur 3 ma at 1 v; max reverse cur 1 ma at 50 v	353 0011 00
E203	Discriminator detector	RECTIFIER, Selenium: forward 16 vdc, 1 ma min; reverse 75 vdc 50 microamps max	353 0020 00
E204	Discriminator detector	RECTIFIER, Selenium: forward 16 vdc, 1 ma min; reverse 75 vdc 50 microamps max	353 0020 00
E205	Ambiguity indicator supply	RECTIFIER, Crystal: germanium; min forward cur 3 ma at 1 v; max reverse cur 1 ma at 50 v	353 0011 00
E206	Ambiguity indicator supply	RECTIFIER, Crystal: germanium; min forward cur 3 ma at 1 v; max reverse cur 1 ma at 50 v	353 0011 00
E207	Deviation indicator supply	RECTIFIER: Double bridge; copper oxide	353 0014 00
E208		Not used	
J101	Antenna connector	CONNECTOR, Female contact: single contact; wall mtg	357 9003 00
	Receiver connector	CONNECTOR, female contact: 45 term; mtd on shockmtg	370 2034 00
K101	Autopositioner control	RELAY, Autopositioner operating: Single contact, NO; 26.5 vdc coil	503 5115 003
K102	Autopositioner control	RELAY, Autopositioner operating: Single contact, NO; 26.5 vdc coil	503 5115 003
K103	Autopositioner control	RELAY, circuit control: contacts 1C; 26.5 v coil	410 0062 00
K104	AVC disabling	RELAY, midget, SPDT, 470 ohm coil	410 0059 00
K201	Audio section control	RELAY, rotary: 2 pos; 2 wafers each with 4PDT and one wafer with 2PDT; shorting	410 0061 00
L101	H-F injection osc cathode	COIL, RF choke: .5 mh	503 4535 001

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
L102	L-F injection osc cathode	COIL, RF choke: .5 mh	503 4535 00
P201	Receiver connector	CONNECTOR, male contact: 45 term; wall mtg	370 2033 00
R101		RESISTOR: Not used	
R102	R-F amp grid	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R103	R-F amp cathode	RESISTOR: 220 ohm ±10%, 1/2 w	745 1058 00
R104		RESISTOR: Not used	
R105		RESISTOR: Not used	
R106	1st mixer grid	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R107	1st mixer cathode	RESISTOR: 1000 ohm ±10%, 1/2 w	745 1086 00
R108	1st mixer screen	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R109	1st mixer h-v dropping	RESISTOR: .22 megohm ±10%, 1/2 w	745 1184 00
R110	Variable i-f amp grid	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R111	Variable i-f amp cathode	RESISTOR: 1000 ohm ±10%, 1/2 w	745 1086 00
R112		RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R113	Variable i-f amp plate	RESISTOR: 33,000 ohm ±10%, 1/2 w	745 1149 00
R114	AVC Control	RESISTOR, Variable: 5000 ohm linear; 1 w; 100 WV	376 0053 00
R115	2nd mixer cathode	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00
R116	2nd mixer screen	RESISTOR: .22 megohm ±10%, 1/2 w	745 1184 00
R117	2nd mixer plate	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R118	1st fixed i-f amp grid	RESISTOR: .22 megohm ±10%, 1/2 w	745 1184 00
R119	Variable i-f amp screen	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R120	1st fixed i-f amp cathode	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00
R121		RESISTOR: Not used	
R122	1st fixed i-f amp plate	RESISTOR: 33,000 ohm ±10%, 1/2 w	745 1149 00
R123	2nd fixed i-f amp grid	RESISTOR: .22 megohm ±10%, 1/2 w	745 1184 00
R124	L-F injection osc plate	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00
R125	2nd fixed i-f amp cathode	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00
R126		RESISTOR: Not used	
R127	L-F injection osc screen	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00
R128	2nd fixed i-f plate	RESISTOR: 33,000 ohm ±10%, 1/2 w	745 1149 00
R129	3rd fixed i-f amp grid	RESISTOR: 3300 ohm ±10%, 1/2 w	745 1107 00
R130		RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R131	3rd fixed i-f plate and screen	RESISTOR: 18,000 ohm ±10%, 1/2 w	745 1139 00
R132	Detector load	RESISTOR: 22,000 ohm ±5%, 1/2 w	745 1141 00
R133	Detector load	RESISTOR: 47,000 ohm ±5%, 1/2 w	745 1155 00
R134	AVC detector load	RESISTOR: .47 megohm ±5%, 1/2 w	745 1197 00
R135	Squelch voltage dividing	RESISTOR: 10,000 ohm ±5%, 1/2 w	745 1127 00
R136	Squelch voltage developing	RESISTOR: 82,000 ohm ±5%, 1/2 w	745 1166 00
R137	Squelch voltage developing	RESISTOR: 82,000 ohm ±5%, 1/2 w	745 1166 00
R138	Squelch voltage developing	RESISTOR: 10,000 ohm ±10%, 1/2 w	745 1128 00
R139	1st audio amp grid	RESISTOR: 10,000 ohm ±10%, 1/2 w	745 1128 00
R140	AVC filter	RESISTOR: 2.2 megohm ±10%, 1/2 w	745 1226 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R141	Noise limiter coupling	RESISTOR: .27 megohm ±10%, 1/2 w	745 1188 0
R142	Noise limiter voltage dividing	RESISTOR: .27 megohm ±10%, 1/2 w	745 1188 0
R143	Noise limiter cathode	RESISTOR: .27 megohm ±10%, 1/2 w	745 1188 0
R144	1st audio cathode	RESISTOR: 1000 ohm ±10%, 1/2 w	745 1086 0
R145	1st audio grid	RESISTOR: 0.10 megohm ±10%, 1 w	745 3170 0
R146	1st audio grid	RESISTOR: .22 megohm ±10%, 1/2 w	745 1184 0
R147	1st audio h-v dropping	RESISTOR: 47,000 ohm ±10%, 1/2 w	745 1156 0
R148	Output audio grid	RESISTOR:	
R149	Output audio grid	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 0
R150	Output audio grid	RESISTOR: .12 megohm ±10%, 1/2 w	745 1174 0
R151	Output audio cathode	RESISTOR: 820 ohm ±10%, 1/2 w	745 1083 0
R152	Squelch control grid	RESISTOR: 1 megohm ±10%, 1/2 w	745 1212 0
R153	Receiver plate voltage dropping	RESISTOR: 2200 ohm ±10%, 1 w	745 3100 0
R154	Receiver screen voltage dropping	RESISTOR: 10,000 ohm ±10%, 2 w	745 5128 0
R155	H-F injection osc grid	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 0
R156	H-F injection osc cathode	RESISTOR: 150 ohm ±10%, 1/2 w	745 1051 0
R157	H-F injection osc screen	RESISTOR: 56,000 ohm ±10%, 1/2 w	745 1160 0
R158		RESISTOR: Not used	
R159	Freq. mult grid	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 0
R160	Freq. mult cathode	RESISTOR: 220 ohm ±10%, 1/2 w	745 1058 00
R161	Freq. mult screen	RESISTOR: 47,000 ohm ±10%, 1/2 w	745 1156 00
R162	Filament voltage dropping	RESISTOR: .75 ohm	
R163	Filament voltage dropping	RESISTOR: .75 ohm	

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R164		RESISTOR: Not used	
R165	L-F injection osc cathode	RESISTOR: 150 ohm ±10%, 1/2 w	745 1051 00
R166	L-F injection osc cathode	RESISTOR: .10 megohm ±10%, 1/2 w	745 1170 00
R167	AVC voltage developing	RESISTOR: .27 megohm ±10%, 1/2 w	745 1188 00
R168	AVC voltage dividing	RESISTOR: .56 megohm ±10%, 1/2 w	745 1202 00
R169		RESISTOR: Not used	
R170		RESISTOR: Not used	
R171		RESISTOR: Not used	
R172	H-F exciter & 1st mixer voltage dropping	RESISTOR: 2200 ohm ±10%, 1/2 w	745 1100 00
R173	AVC amp h-v dropping	RESISTOR: 47,000 ohm ±10%, 1/2 w	745 1156 00
R174	AVC amp plate decoupling	RESISTOR: 68,000 ohm ±5%, 1/2 w	745 1162 00
R175		RESISTOR: 6800 ohm ±10%, 1/2 w	745 1121 00
R176	Audio gain control	RESISTOR: 50,000 ohm ±20%, 1 w	376 0056 00
R201	Reference channel 1st amp grid	RESISTOR: 1 megohm ±10%, 1/4 w	745 0212 00
R202	Reference channel 1st amp cathode	RESISTOR: 1000 ohm ±10%, 1/4 w	745 0086 00
R203	Reference channel 1st amp plate	RESISTOR: .10 megohm ±10%, 1/4 w	745 0170 00
R204	Reference channel 2nd amp grid	RESISTOR: .27 megohm ±10%, 1/4 w	745 0188 00
R205	Deviation indicator output coupling	RESISTOR: 2200 ohm ±10%, 1/4 w	745 0100 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
*R206	Phase splitting network	RESISTOR:	
R207	Reference channel 2nd amp cathode	RESISTOR: 680 ohm ±5%, 1/4 w	745 0078 00
R208	Reference channel 2nd amp cathode	RESISTOR: 820 ohm ±5%, 1/4 w	745 0082 00
R209	Discriminator load	RESISTOR: .27 megohm ±10%, 1/4 w	745 0188 00
R210	Discriminator load	RESISTOR: .27 megohm ±10%, 1/4 w	745 0188 00
R211	Phase splitting network	RESISTOR: 500,000 ohm ±1%, 1/2 w	722 0212 00
R212	Discriminator output coupling	RESISTOR: 82,000 ohm ±10%, 1/4 w	745 0167 00
R213	Phase splitting network	RESISTOR: 500,000 ohm ±1%, 1/2 w	722 0212 00
R214	Phase splitting network	RESISTOR: 500,000 ohm ±1%, 1/2 w	722 0212 00
R215	Phase splitting network	RESISTOR: 500,000 ohm ±1%, 1/2 w	722 0212 00
*R216	Phase splitting network	RESISTOR:	
R217	V203 grid coupling	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R218	V203 grid coupling	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R219	V202 grid coupling	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R220	V202 grid coupling	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R221	V203 cathode	RESISTOR: 1500 ohm ±1%, 1/4 w	721 0116 00
R222	V203 cathode	RESISTOR: 1300 ohm ±1%, 1/4 w	721 0131 00
R223	V204 input coupling	RESISTOR: 560 ohm ±10%, 1/4 w	745 0076 00
R225	V202 cathode	RESISTOR: 1000 ohm ±1%, 1/4 w	721 0115 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R226	V202 cathode	RESISTOR: 800 ohm ±1%, 1/4 w	721 0114 00
R227	V204 cathode	RESISTOR: 560 ohm ±5%, 1/4 w	745 0075 00
R228	Ambiguity indicator voltage developing	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R229	Ambiguity indicator voltage	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R230	Deviation indicator coupling	RESISTOR: 470 ohm ±5%, 1/2 w	707 0217 00
R231	Deviation indicator coupling	RESISTOR: Variable, 100 ohm ±10%, linear, 2 w, 300° rotation	377 0104 00
R232	Deviation indicator coupling	RESISTOR: 470 ohm ±5%, 1/2 w	707 0217 00
R233	Deviation indicator coupling	RESISTOR: 820 ohm ±10%, 1/4 w	745 0083 00
R234	Deviation indicator coupling	RESISTOR: 1500 ohm ±10%, 1/4 w	745 0093 00
R235	Deviation indicator coupling	RESISTOR: 27 ohm ±10%, 1/4 w	745 0020 00
R236	Deviation indicator coupling	RESISTOR: 180 ohm ±10%, 1/4 w	745 0055 00
R237	V206 output coupling	RESISTOR: 6800 ohm ±10%, 1/4 w	745 0121 00
R238	90 cycle filter coupling	RESISTOR: 1000 ohm ±5%, 1 w	708 0109 00
R239	150 cycle filter coupling	RESISTOR: 1000 ohm ±5%, 1 w	708 0109 00
R240	90 cycle & 150 cycle filter coupling	RESISTOR, Variable: 15,000 ohm linear; 4 w; .016 amp	377 0041 00
R241	V206 cathode	RESISTOR: 560 ohm ±5%, 1/4 w	745 0075 00
R242	Discriminator output coupling	RESISTOR: 82,000 ohm ±10%, 1/4 w	745 0167 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R243	V205 output coupling	RESISTOR: .12 megohm ±10%, 1/4 w	745 0174 00
R244	V206 grid	RESISTOR: .27 megohm ±5%, 1/4 w	745 0187 00
R245	V205 & V206 grid	RESISTOR: 39,000 ohm ±5%, 1/4 w	745 0152 00
R246	V205 plate	RESISTOR: .22 megohm ±10%, 1/4 w	745 0184 00
R247	V205 plate	RESISTOR: .22 megohm ±10%, 1/4 w	745 0184 00
R248	V205 plate dropping	RESISTOR: .22 megohm ±10%, 1/4 w	745 0184 00
R249	V205 cathode	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R250	V205 cathode	RESISTOR: 5600 ohm ±10%, 1/4 w	745 0118 00
R251	V205 grid	RESISTOR: .47 megohm ±10%, 1/4 w	745 0198 00
R252	Filter input resis-ance	RESISTOR: .12 megohm ±10%, 1/4 w	745 0174 00
R253	T203 primary series	RESISTOR: 470 ohm ±10%, 1/4 w	745 0072 00
*R254	V208 cathode	RESISTOR:	
R255	Network resistor	RESISTOR: .22 megohm ±5%, 1/4 w	745 0183 00
R256		RESISTOR: Not used	
R257	V207 grid	RESISTOR: .82 megohm ±5%, 1/4 w	745 0208 00
R258		RESISTOR: Not used	
R259	V207 Cathode	RESISTOR: 1500 ohm ±10%, 1/4 w	745 0093 00
R260	V207 plate	RESISTOR: 56,000 ohm ±5%, 1/4 w	745 0159 00
R261	V207 plate	RESISTOR: 56,000 ohm ±5%, 1/4 w	745 0159 00
R262		RESISTOR: Not used	
R263		RESISTOR: 22,000 ohm ±10%, 1/4 w	745 0142 00
R264		RESISTOR: Not used	
R265	V208 Section 1 grid	RESISTOR: .27 megohm ±10%, 1/4 w	745 0188 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R266	V208 Section 2 grid	RESISTOR: .27 Megohm ±10%, 1/4 w	745 0188 00
R267	V208 common cathode	RESISTOR: 3900 ohm ±10%, 1/4 w	745 0135 00
R268	V208 section 2 cathode	RESISTOR: 470 ohm ±10%, 1/4 w	745 0072 00
R269	V208 section 1 cathode	RESISTOR: 470 ohm ±10%, 1/4 w	745 0072 00
R270		RESISTOR: .10 megohm ±10%, 1/4 w	
R271	Voltage divider	RESISTOR: 50 ohm ±5%, 5 w	747 9022 00
R272	Voltage divider	RESISTOR: 160 ohm ±5%, 7 w	747 0074 00
*R273	Phase splitting network	RESISTOR:	
*R274	Phase splitting network	RESISTOR:	
R275	V206 section 2 grid	RESISTOR: .68 ohm ±5%, 1/4 w	745 0204 00
R276	V206 section 2 grid	RESISTOR: .18 megohm ±5%, 1/4 w	745 0180 00
R277	Q Determining	RESISTOR: 1000 ohm ±5%, 1/4 w	745 0085 00
R278	V203 cathode balancing	RESISTOR: 500 ohm ±10%, 2 w	377 0106 00
*R279	V203 cathode balancing	RESISTOR:	
R280	V202 cathode balancing	RESISTOR: 500 ohm ±10%, 2 w	377 0106 00
*R281	V202 cathode balancing	RESISTOR:	
*R282	T204, T205 coupling		
R283	V207 balancing	RESISTOR: 500 ohm ±10%, 2 w	377 0106 00
R284	V201 grid	RESISTOR: .27 megohm ±10%, 1/4 w	745 0188 00
R285		RESISTOR: 10,000 ohm ±10%, 1/2 w	745 1128 00
S101	Coarse frequency positioner	SWITCH: Rotary, 20 position	269 1079 00
S102	Front phase localizer sensitivity & RCI disabling Rear coarse mod. index & ambiguity disabling	SWITCH: Rotary, 20 position	269 1081 00
S103	Front antenna & phase tone rotary Rear omni-phase localizer	SWITCH: Rotary, 20 position	269 1080 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
S104	Aux fine frequency positioner & fine modulation index	SWITCH: Rotary; 20 position	269 1083 00
S105	Fine frequency positioner	SWITCH: Rotary; 20 position	269 1082 00
S106	Coarse frequency osc.	SWITCH: Rotary; 20 position	269 1084 00
S107	Fine frequency osc.	SWITCH: Rotary; 20 position	269 1085 00
T101	Antenna coil	COIL ASSEM, Antenna: 108-135.9 mc; 2 mc wide	520 3813 00
T102	First mixer	COIL ASSEM, Mixer: 108-135.9 mc; 2 mc wide	520 3814 00
T103	Variable frequency i-f	COIL ASSEM: 19.5-21.4 mc	503 7623 00
T104	Second mixer	COIL ASSEM: 19.5-21.4 mc	503 7624 00
T105	First fixed freq. i-f	COIL ASSEM, IF transformer: 3.2 mc	503 7625 00
T106	Second fixed freq. i-f	COIL ASSEM, IF transformer: 3.2 mc	503 7625 00
T107	Third fixed freq. i-f	COIL ASSEM, IF transformer: 3.2 mc	503 7625 00
T108	Fixed freq. i-f output	COIL ASSEM, IF transformer: 3.2 mc	503 7625 00
T110	Audio output	TRANSFORMER, AF: 300-3000 cps; pri: 20,000 ohm, 1000 TV; sec: 500 ohm, 1000 TV	677 0198 00
T111	H-F injection mult.	COIL ASSEM, HFO amplifier: 88.5-114.5 mc	520 3816 00
T112	H-F injection osc. plate	COIL ASSEM, HFO mixer: 29.5-38.16 mc	520 3815 00
T113	L-F injection osc plate	COIL ASSEM: 16.3-18.2 mc	503 7607 00
T114	Bias osc.	COIL ASSEM, Bias oscillator:	503 7325 00
T201	Frequency discriminator	TRANSFORMER: Special audio transformer and coil assem; Pri: 600 ohm, 500 TV rms; Sec #1: 50 v, 450/500 ohm, 500 TV rms, Sec #2: 12.5 v, 150 ohm, 500 TV rms	677 0197 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
T202	30 cycle amp. input	TRANSFORMER: Audio input, single freq. 30 cps; Pri: 330 ohm ±20%; Sec #1: 7500 ohm ±25%; sec #2: 7500 ohm ±25%	677 0203 00
T203	Phase detector input	TRANSFORMER: Audio input, single freq. 30 cps; pri: 330 ohm ±20%, Sec #1: 7500 ohm ±25%; sec #2: 7500 ohm ±25%	677 0203 00
T204	30 cycle amp. output (reference channel)	TRANSFORMER: Audio output; single freq. 30 cps; Pri: 25,000 ohm plate to plate load ±15%, 1000 TV, 72 v ac; Sec #1: 1000 ohm, 1000 TV, 8.5 v ac; Sec #2: 1000 ohm, 1000 TV, 8.5 v ac; Sec #3: 20,000 ohm, 1000 TV, 8.5 v ac, CT	677 0199 00
T205	30 cycle amp. output (variable channel)	TRANSFORMER: Audio output; single freq. 30 cps; Pri: 25,000 ohm plate to plate load ±15%, 1000 TV, 72 v ac; Sec #1: 1000 ohm, 1000 TV, 8.5 v ac; Sec #2: 1000 ohm, 1000 TV, 8.5 v ac; Sec #3: 20,000 ohm, 1000 TV, 8.5 v ac, CT	677 0199 00
T206	Servo amp. output	TRANSFORMER: Saturable reactor; inductance at 5 v, 400 cps: 44 mh +40-10% at 1 ma dc; max current in DC winding 8 ma; max current in AC winding 110 ma	678 0204 00
V101	RF amp.	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V102	First converter	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V103	19.5-21.4 mc i-f	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V104	Second converter	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V105	First low freq. i-f	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V106	Second low freq. i-f	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V107	Third low freq. i-f	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V108	Det & AVC rectifier	TUBE: Type 5670; dual triode	253 0002 00
V109	Noise limiter & audio amp.	TUBE: Type 5670; dual triode	253 0002 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
V110	Audio output and C.O. squelch	TUBE: Type 5670; dual triode	253 0002 00
V111	HFO buffer amp.	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V112	First HFO and mult.	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V113	Second HFO and mult.	TUBE: Type 5654/6AK5; RF amplifier pentode	253 0001 00
V114	Bias osc.	TUBE:Type 5670; dual triode	253 0002 00
V115	AVC amp. and gate	TUBE: Type 5670; dual triode	253 0002 00
V116	Screen Voltage Regu.	TUBE: Type OA2; Voltage regulator	257 0052 00
V201	10 KC amplifier	TUBE: Type 5670; dual triode	253 0002 00
V202	Resolver control	TUBE: Type 5670; dual triode	253 0002 00
V203	Resolver control	TUBE: Type 5670; dual triode	253 0002 00
V204	30 cycle amplifier	TUBE: Type 5670; dual triode	253 0002 00
V205	Variable channel amp.	TUBE: Type 5670; dual triode	253 0002 00
V206	Variable channel output amp.	TUBE: Type 5670; dual triode	253 0002 00
V207	Phase detector	TUBE: Type 5670; dual triode	253 0002 00
V208	Resolver control	TUBE: Type 5670; dual triode	253 0002 00
XV101, XV102, XV103, XV104, XV105, XV106, XV107	Sockets for V101, V102, V103, V104, V105, V106, V107	SOCKET, tube: 7 contact, miniature shielded	220 1034 00
XV108, XV109, XV110	Sockets for V108, V109, V110	SOCKET, tube: 9 contact, miniature	220 1051 00
XV111, XV112, XV113, XV116	Sockets for V111, V112, V113, V116	SOCKET, tube: 7 contact; miniature; shielded	220 1034 00
XV114, XV115, XV201, XV202, XV203,	Sockets for V114, V115, V201, V202, V203,	SOCKET, tube: 9 contact, miniature	220 1051 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
XV204, XV205, XV206, XV207, XV208	Sockets for V204, V205, V206, V207, V208	SOCKET, tube: 9 contact, miniature	220 1051 00
XY101 thru XY114	Sockets for Y101 thru Y114	SOCKET BOARD ASSEM, crystal: coarse freq. oscillator	503 5102 002
XY115 thru XY134	Sockets for Y115 thru Y134	SOCKET BOARD ASSEM, crystal: fine freq. oscillator	
Y101	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7375 kc	291 5176 00
Y102	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7541.667 kc	291 5177 00
Y103	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7708.333 kc	291 5178 00
Y104	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7875 kc	291 5179 00
Y105	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8041.667 kc	291 5180 00
Y106	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8208.333 kc	291 5181 00
Y107	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8375 kc	291 5182 00
Y108	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8541.667 kc	291 5183 00
Y109	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8708.333 kc	291 5184 00
Y110	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8875 kc	291 5185 00
Y111	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9041.667 kc	291 5186 00
Y112	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9208.333 kc	291 5187 00
Y113	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9375 kc	291 5188 00
Y114	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9541.667 kc	291 5189 00
Y115	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8150 kc	291 5190 00
Y116	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8200 kc	291 5191 00
Y117	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8250 kc	291 5192 00
Y118	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8300 kc	291 5193 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
Y119	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8350 kc	291 5194 00
Y120	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8400 kc	291 5195 00
Y121	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8450 kc	291 5196 00
Y122	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8500 kc	291 5197 00
Y123	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8550 kc	291 5198 00
Y124	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8600 kc	291 5199 00
Y125	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8650 kc	291 5200 00
Y126	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 5800 kc	291 5210 00
Y127	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8750 kc	291 5202 00
Y128	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8800 kc	291 5203 00
Y129	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8850 kc	291 5204 00
Y130	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 5933.333 kc	291 5211 00
Y131	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8950 kc	291 5206 00
Y132	2nd h-f osc.	CRYSTAL: Type CF-18/u; freq 9000 kc	291 5207 00
Y133	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 9050 kc	291 5208 00
Y134	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 9100 kc	291 5209 00
Z101	Audio filter	REACTOR, Filter: High pass; 300 cps, less than 3 db down reference 1000 cps response; 150 cps and below, more than 20 db; 10 v rms output	673 0166 00
	Receiver shock mount assembly	MOUNT, Vibration: Basic assembly	503 5801 00
	Rubber mounting feet	MOUNT SET, Vibration: 4-6 lb. load (qty 4)	200 0106 00
416N-1 POWER SUPPLY			
C301	High voltage filter	CAPACITOR, Paper: 3.9 mf ±3% at 60 cps, 330 WV ac at 60 cps	930 0096 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C302	High voltage filter	CAPACITOR, Paper: 3.9 mf ±3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
C303	High voltage noise filter	CAPACITOR, Paper: 0.1 mf ±20%, 600 WV	930 0029 00
C304	Low voltage noise filter	CAPACITOR, Paper: 1.3 mf ±20%, 50 WV	930 0004 00
C305	Primary noise filter	CAPACITOR, Mica: 10,000 mmf ±20%, 300 WV	JAN type # CM35A103M
C306	Secondary noise filter	CAPACITOR, Mica: 6200 mmf ±20%, 500 WV	JAN type # CM35A622M
C307	High voltage filter	CAPACITOR, Paper: 3.9 mf ±6% at 60 cps, 330 WV ac at 60 cps	930 0095 00
C308	High voltage filter	CAPACITOR, Paper: 3.9 mf ±6% at 60 cps, 330 WV ac at 60 cps	930 0095 00
D301	Receiver power	DYNAMOTOR: Input: 26.5 v dc at 2.6 amp; output: 260 v dc at .135 amp; (includes C305 and C306 listed above)	231 0036 00
L301	High voltage filter	REACTOR, Filter: 3.62 hy ±5% at 1.3 v, 30 cps, 1600 rms TV	678 0210 00
L302	High voltage filter	REACTOR, Filter: 7.5 hy, 10 v, 60 cps; 1600 rms TV	678 0211 00
L303	High voltage noise filter	COIL, RF Choke: 1 mh ±10%, 300 ma	240 5800 00
L304	Primary power noise filter	COIL, RF Choke: .058 mh;powdered iron core	240 0048 00
P301	Power plug	CONNECTOR, Male Contact: 6 term, wall mtg	365 2060 00
P302	Mounting base power plug	CONNECTOR, Male Contact: 3 term, wall mtg	357 3012 00
X301	Mounting base power socket	CONNECTOR, Female contact: 6 term	366 2060 00

314U-1 Control Unit

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
I401	Dial light	LAMP, Instrument: 3 v, 0.19 amp; special screw base	262 0064 00
S401A	Nav. rec. megacycle	SWITCH, rotary: 14 position; bakelite	269 1073 00
S401B	Interpolation	SWITCH, rotary: 14 position; bakelite	269 1074 00
S401C	DME Megacycle	SWITCH, rotary: 14 position; bakelite	269 1075 00
S401D	Nav. Rec. tenth megacycle	SWITCH, rotary: 20 position; bakelite	269 1076 00
S401E	Glide path tenth megacycle	SWITCH, rotary: 20 position; bakelite	269 1077 00
S401F	DME tenth megacycle	SWITCH, rotary: 20 position; bakelite	269 1078 00
S402	90/150 phase	SWITCH, toggle: SPST; 3 amp, 250 v	260 0701 00
351A-1 ACCESSORY UNIT			
	Filter (qty 4)	CAPACITOR, Paper: 3.9 mf ±6% at 60 cps; 330 WV ac, 60 cps	930 0095 00
		CONNECTOR: Female contact: 45 term	370 2034 00
P501	Omni-bearing connector (#1)	CONNECTOR, female contact: 17 term; wall mtg; shell size 20	357 9023 00
P502	Omni-bearing connector (#2)	CONNECTOR, female contact: 17 term; wall mtg; shell size 20	357 9023 00
P503	Servo amplifier connector (pilot)	CONNECTOR, female contact. 6 term; wall mtg	366 2060 00
P504	Servo amplifier connector (co-pilot)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P505	Servo amplifier connector (navigator)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P506	Power supply connector (#1)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P507	Power supply connector (#2)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P508	Rear connector	CONNECTOR, male contact: 45 term; wall mtg	370 2033 00
	Accessory unit shock mount assembly	MOUNT, vibration: Basic assembly	503 5801 004
	Rubber mounting feet	MOUNT SET, vibration: 7-10 lb. load (qty 4)	200 0 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C601	Cathode bypass	CAPACITOR, Paper: .2 mf ±20%, 120 WV	931 0151 00
C602	Cathode bypass	CAPACITOR, Paper: .2 mf ±20%, 120 WV	931 0151 00
C603 C604	Output filter	CAPACITOR, Paper: Dual sect; .1/.1 mf +40 -15%, 600 WV	961 5038 00
C605	Output filter	CAPACITOR, Paper: 2mf - 20+30%, 100 WV	931 0039 00
P601	Power plug	CONNECTOR, Male Contact: 6 term chassis mtg	365 2060 00
R601	Input resistance	RESISTOR: 470 ohm ±20%, 1/2 w	745 1073 00
R602	V601 grid 7 return	RESISTOR: 270,000 ohm ±10%, 1/4 w	745 0188 00
R603	V601 grid 3 return	RESISTOR: 270,000 ohm ±10%, 1/4 w	745 0188 00
R604	V601 cathode 2	RESISTOR: 2700 ohm ±10%, 1/4 w	745 0104 00
R605	V601 cathode 8	RESISTOR: 2700 ohm ±10%, 1/4 w	745 0104 00
R606	V601 Common cathode	RESISTOR: 1500 ohm ±10%, 1/4 w	745 0093 00
T601	Amplifier input	TRANSFORMER, Input: Turns ratio 1:20; Pri reactance greater than 1000 ohms at 0.25 v rms 400 cps; Pri input 0-5 v, 400 cps	677 0220 00
T602	Amplifier output	REACTOR, Saturable: DC winding: 4750 ohms ±20%; 8 ma max: AC winding: 7.5 ohm ±10%; 110 ma max; 500 TV rms	678 0204 00
T603	Auto-transformer	TRANSFORMER, auto: 400 cps; 150 v, 10 ma/115 v, 100 ma/26.5 v; 230 ma/ 6.3 v, 350 ma; 2500 TV	672 0221 00
V601	Amplifier	TUBE, Electron: Type 2C51, dual triode	253 0002 00
XV601	Socket for V601	SOCKET, Tube: Miniature, 9 term, phenolic	220 1051 00
336A-1 OMNI-BEARING SELECTOR			
B701	Resolver	AUTOSYN RESOLVER: 2 phase stator for 30 cyc; single phase rotor; voltage ratio: pri excited with 1 v, 30 cps, sec 0.465 v ±10% max	230 0077 00
I701	Dial Lamp	LAMP, Instrument: 3 v, 0.19 amp; special screw base	262 0064 00
M701	Indicator	METER: 250-0-250 microamperes DC; perm magnet movable coil	458 0112 00
P701	Connector	CONNECTOR, Male Contact: 10 term; wall mtg; shell size 18	357 3006 00
S701	Switch	SWITCH: Consists of:	
		SEGMENT: 2 stator contacts (qty 2)	503 7161 001
		CONTACT: Right	503 5342 001
		CONTACT: Left	503 5343 001
		SHAFT: Arm stop assembly	503 5328 001

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
337A-1 OMNI-BEARING INDICATOR			
B801	Control motor	MOTOR: 2 phase 400 cps, 18 v rms and 1.5 w per phase	230 0107 00
B802	Phase shifter	AUTOSYN RESOLVER: 2 phase stator for 30 cyc; single phase rotor; voltage ratio: pre excited with 1 v, 30 cps, sec 0.465 v ±10% max	230 0077 00
B803	Differential	AUTOSYN DIFFERENTIAL: Y connected 3 phase rotor and stator; normal excitation output voltage from 26 v 400 cps single phase excited autosyn	230 0076 00
P801	Control wire connector	CONNECTOR: 17 contact plug, pin insert, box mtg.	357 3003 00

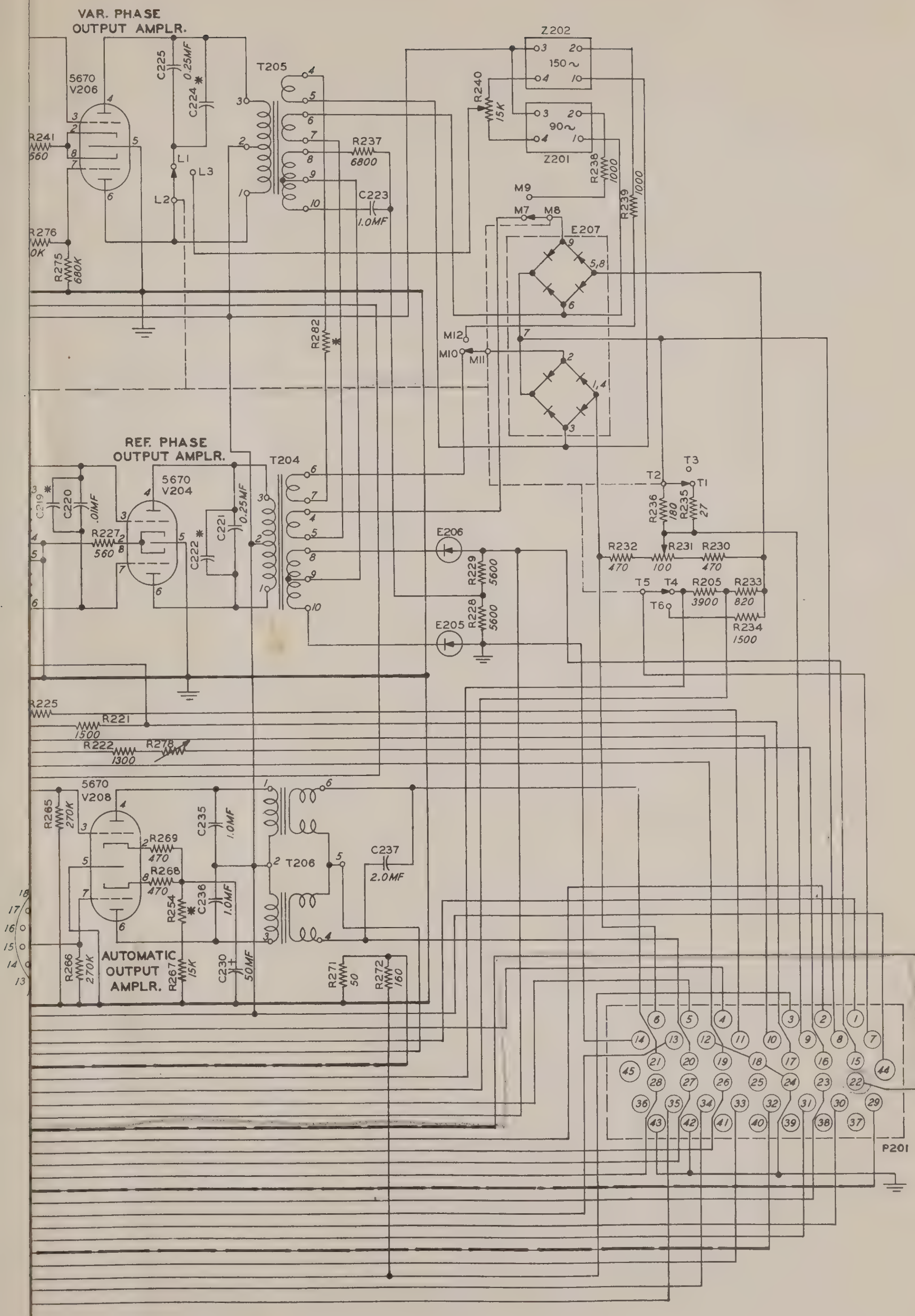


Figure 2-21 51R-1 Schematic

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
337A-1 OMNI-BEARING INDICATOR			
B801	Control motor	MOTOR: 2 phase 400 cps, 18 v rms and 1.5 w per phase	230 0107 00
B802	Phase shifter	AUTOSYN RESOLVER: 2 phase stator for 30 cyc; single phase rotor; voltage ratio: pre excited with 1 v, 30 cps, sec 0.465 v ±10% max	230 0077 00
B803	Differential	AUTOSYN DIFFERENTIAL: Y connected 3 phase rotor and stator; normal excitation output voltage from 26 v 400 cps single phase excited autosyn	230 0076 00
P801	Control wire connector	CONNECTOR: 17 contact plug, pin insert, box mtg.	357 3003 00

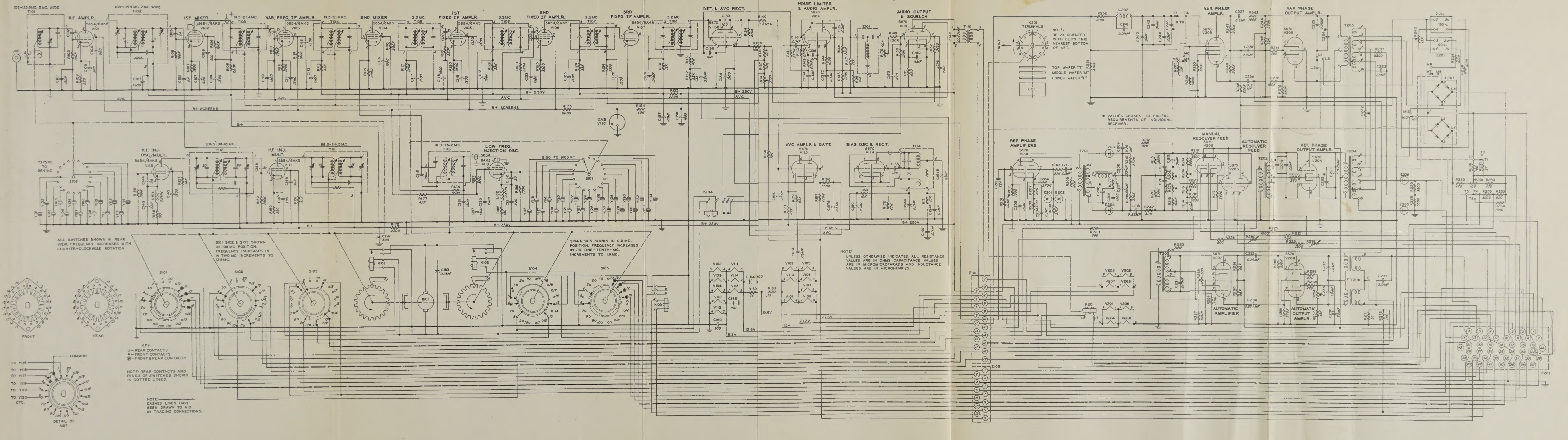


Figure 2-21 51R-1 Schematic